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CANADIAN ELECTRONICS ENGINEERING

OCT 10 1961

EIA forms committees to study research and export problems

Correction of non-linear distortion in transistor amplifiers

Aural and visual aids set high standard for auditoriums

Efficient three-phase supply powers Xenon arc discharge lamps

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CANADIAN ELECTRONICS ENGINEERING

Volume five number **10** **October 1961**

Electronic Industries Association forms committees to study research, exports — Feature Report — **33**

Correction of non-linear distortion in transistor amplifiers

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Improvements in non-linear distortion of grounded emitter amplifiers can be obtained by employing non-linear correcting networks. This paper describes the development of these networks for voltage and power amplifiers in single-ended and push-pull circuits, and class A and class B conditions. Consideration is also given to the grounded collector and grounded base configurations with examples of practical correcting networks for each of these cases. In general, improvements in non-linear and intermodulation distortion of greater than 10 db are achieved for all circuits. This is usually accomplished by a slight increase in gain due to the general improvement of the form factor of the output signal at high levels.

G. W. Holbrook, was born in Asquith, Sask. He graduated from London University with the degree of BSc. then went on to receive his MSc from Queen's University in 1949, and his PhD from London University in 1956. From 1939 until 1946, Dr. Holbrook served with the British Army, then served with the Canadian Army until 1952 with the rank of Lt.-Col. In 1952 he joined the Royal Military College of Canada as head of the department of electrical engineering. Earlier this year he was appointed President of Nova Scotia Technical College, Halifax.

E. P. Todosiev graduated from Queen's University in electrical engineering in 1959 and received his MSc from the University of Toronto a year later. At present, he is at Ohio State University, working towards his PhD degree.

Efficient three-phase supply powers Xenon arc discharge lamps

42

Xenon arc discharge lamps are suitable for use in movie projectors and for research purposes. Their electrical characteristics are such that they require special power supplies. The voltage needed to start a lamp is about three times the operating voltage. Since the lamps have small negative resistance, the supplies must have adequate positive resistance. A conventional rectified power supply is, therefore, unsuitable. The supply described in this article takes power from a 575 volt, 60 cps, three phase line. Chokes in the ac line, and resistors in the dc line, are used to drop the starting voltage to operating level. Variacs and buck-boost transformers compensate for supply voltage variations.

M. P. MacMartin was born at Martintown, near Cornwall, Ontario. He graduated from Queens University in 1950 with a BSc degree in electrical engineering. Since then he has been working in the Electrical Engineering Section, Radio and Electrical Engineering Division of the National Research Council.

F. R. Lipsett was born in Vancouver and graduated from the University of British Columbia, having studied engineering physics. He then studied at the Royal Institution in London, England, receiving his PhD degree in 1954. Since then he has been working in the Solid State Group of the Electrical Engineering Section, NRC. He has specialized in the measurement of fluorescence.

Electronic circuits explain the Webber principle of scientific management

45

People exhibit characteristics analogous to electronic circuit functions and after correct classification they can be placed in series or parallel circuit arrangements to produce impressive, if not useful, output. This is a "less than serious" discussion of the principle.

A. P. Harris is a graduate in electrical engineering from McGill University. From 1944 to 1946 he was employed with the Department of Munitions and Supply, and National Research Council. From 1947 to date he has been with the RCAF and Canadian Military Electronics Standards Agency. He is responsible for testing and approval of electronic components and materials, and their application in military equipment.

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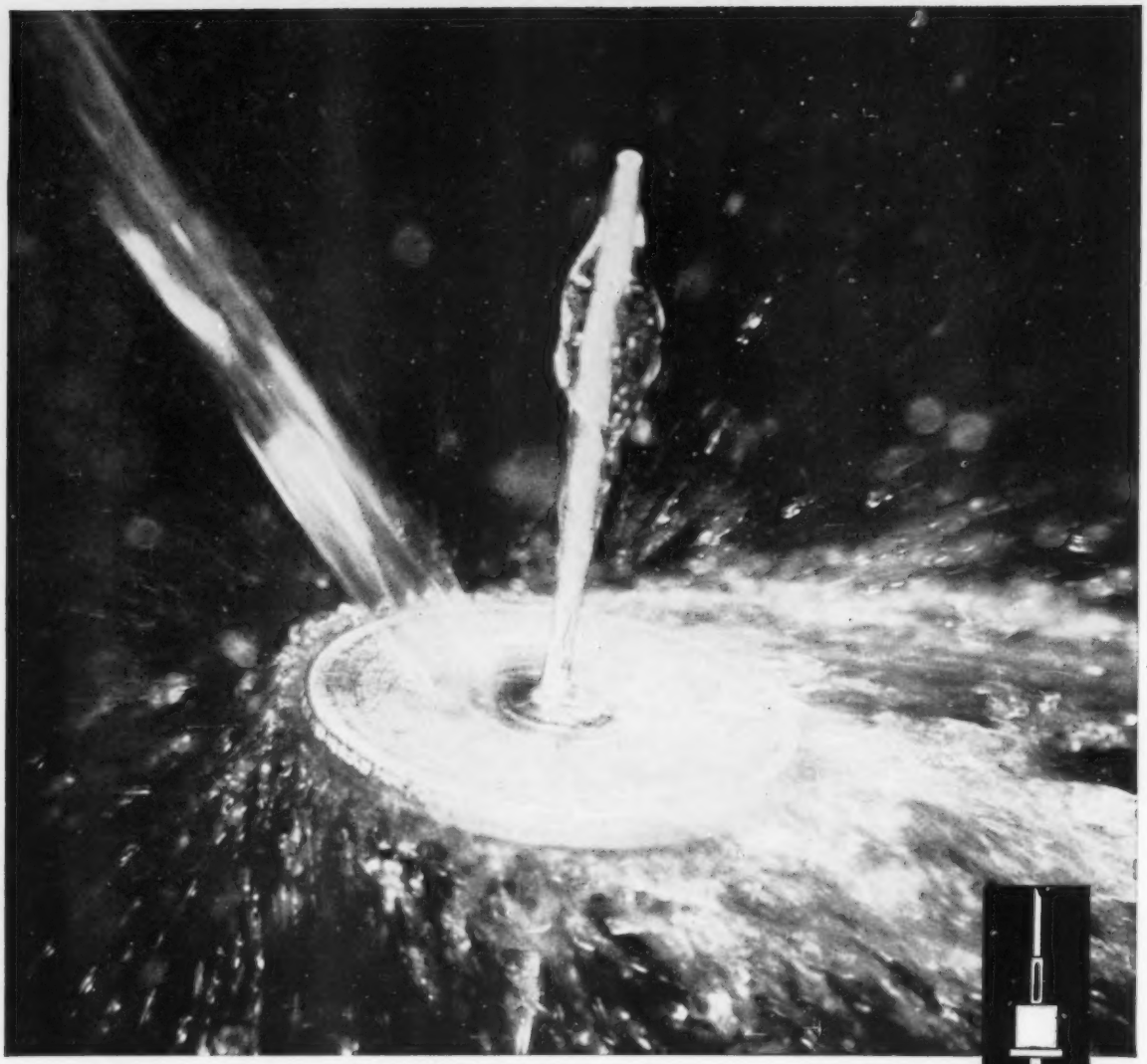

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CONTENTS—continued from page 1

Switching ac with transistors

The basic ac transistor switch utilizing one transistor requires a control current proportional to the load current. This article describes three circuits for applications where low control current is desired, pulsed control signals are to be used, and voltages to be switched are higher than the transistor breakdown voltage.

John Leng was born in London, England, and received Higher National Certificates in electrical engineering (1956) and mechanical engineering (1957) at the Headington School of Engineering, Oxford. He served as an engineering apprentice at Harwell from 1951 until 1956, and as a technical assistant in the electronics division until 1957. Now he is with the electronics branch, Atomic Energy of Canada Ltd.

46

Co-ordinated aural and visual aids set high standard for auditoriums

A description is given of aural and visual aids used at lectures, symposia and conferences held in the auditorium of the Radio and Electrical Engineering Division of the National Research Council, Ottawa. Supplementary facilities used with the system are outlined.

N. Lewrey was born in Surrey, England, and has been employed by the National Research Council as a technical officer in radio and radar for the past 21 years. Previously, he served with Canadian Marconi Co. as a shipboard radio operator and communications engineer, and RCA Victor Co. as a service engineer. In 1929 he participated in the first television transmission in Montreal from station CKAC.

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Authorized as second class mail by the Post Office Department, Ottawa, and for payment of postage in cash.

Printed and published by Maclean-Hunter Publishing Company Limited, 481 University Avenue, Toronto 2, Canada. Tel.: 362-5311.

Offices at 1242 Peel Street, Montreal, UN. 6-9841, Room 1004, The Burrard Bldg., 1030 West Georgia Street, Vancouver 5, B.C. MU. 3-8254; Maclean-Hunter Limited, 30 Old Burlington St., London W.1, England.

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Other services: The Financial Post Corporation Service; Canadian Press Clipping Service; Commercial Printing Division.

Subscription rates: Canada $5.00 per year, two years $9.00, three years $13.00. Single copy price $1.00. U. S. A., United Kingdom, $10.00 per year; all other countries, $20.00 per year.

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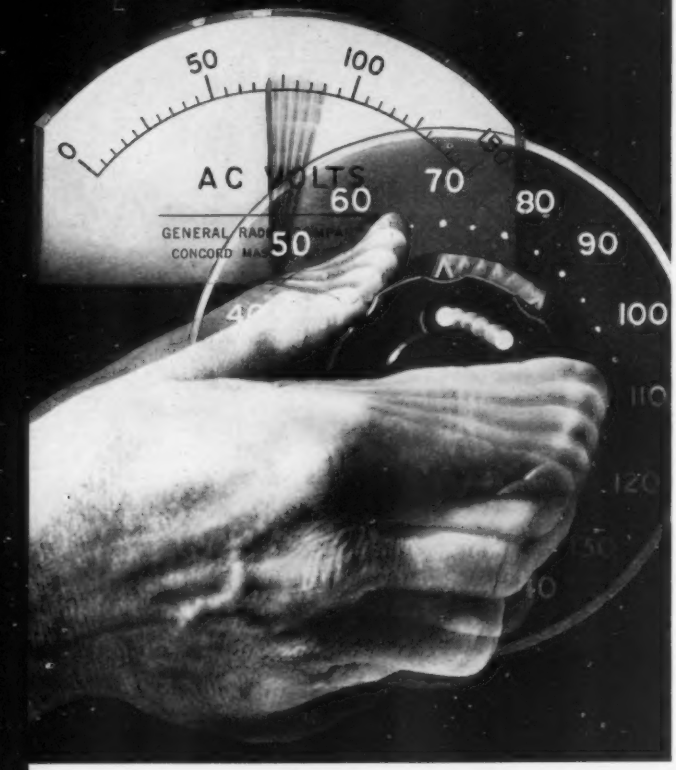

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W2 UNCASED	120	0.37	0-140	2.4	3.1	$15.00
W2M CASED	120	0.31	0-140	2.0	2.6	21.00
W2MT3 PORTABLE	120	0.28	0-140	2.0	2.4	28.00
W5 UNCASED	120	0.94	0-140	6.0	7.8	18.00
W5M CASED	120	0.78	0-140	5.0	6.5	24.00
W5MT3 PORTABLE	120	0.73	0-140	5.0	6.0	32.50
W10 UNCASED	120	1.56	0-140	10.0	13.0	31.00
W10M CASED	120	1.56	0-140	10.0	13.0	44.00
W10MT3 PORTABLE	120	1.56	0-140	10.0	13.0	53.50
W20 UNCASED	120	3.12	0-140	20.0	26.0	48.00
W20M CASED	120	3.12	0-140	20.0	26.0	61.00
W20MT3 PORTABLE	120	3.12	0-140	20.0	26.0	90.00
W30 UNCASED	120	4.32	0-140	30.0	36.0	75.00
W30M CASED	120	3.84	0-140	28.0	32.0	97.00
W50 UNCASED	120	6.0	0-140	50	50	120.00
W50M CASED	120	5.4	0-140	40	45	145.00

*For "O to Line Voltage" Connection.

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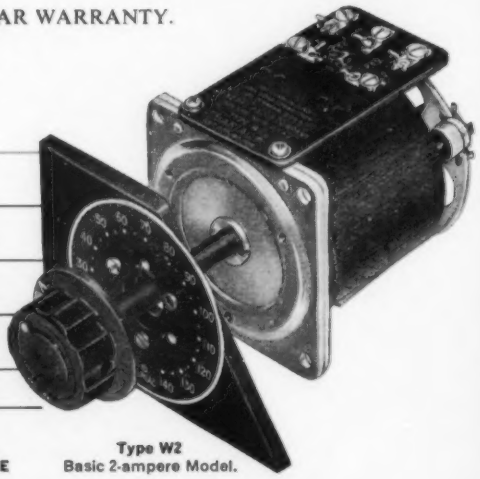

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NEWS HIGHLIGHTS

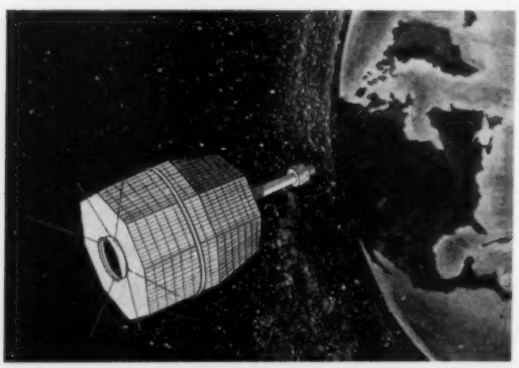
Department of Transport solves problem of how to build a radio range on top of a mountain: — shear off the peak and put the equipment underground.

By next year, aircraft on the Edmonton-Vancouver airway will be guided by an underground radio range, set in the top of a mountain near Enderby, B.C. The Department of Transport expects to award the contract later this year for a $200,000 combined VHF omnidirectional range (VOR) and tactical air navigation (TAGAN) station to be located just below the surface at the top of a 7,000-foot mountain. The equipment to be housed in the structure calls for a round, flat, unobstructed platform 300 feet in diameter. Rather than extend the building's flat roof to that size, the department found it will be cheaper to shear the peak off the mountain and bury the station. The unmanned station is expected to be operational late in 1962.

RCA Victor, Montreal, will build the wide-band receiver for experimental satellite, Project Relay, to demonstrate trans-oceanic television.

Project Relay is sponsored by the United States government and will be a practical test of methods and equipment for world-wide communications by means of an orbiting earth satellite. The system will be used to relay TV, voice communications, data transmission and telegraph across the Atlantic. The satellite will contain both receivers and transmitters. RCA Victor will design and build the receivers and portions of the transmitters at Montreal.

Ground stations in England and France will be able to beam signals via the satellite to similar stations in the United States. Other nations are expected to provide additional ground stations and participate in communications experiments.



Artist's impression of Project Relay communications satellite which will be launched late next summer.

A $2,286,751 contract to produce counter-mortar radars for the Canadian Army has been awarded to Raytheon-Canada.

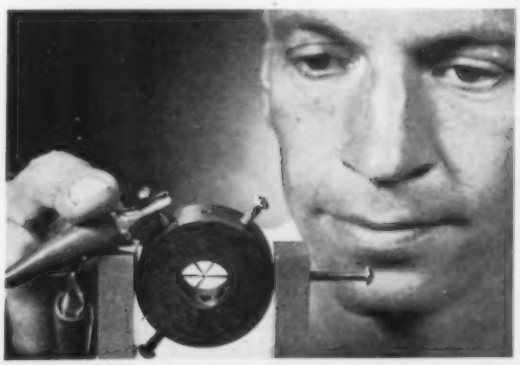
Initial design of the AN/MPQ-501 counter-mortar radars was done by the National Research Council as a development for the Canadian Army. Recent field trials have shown the equipment to be outstanding in performance. Modifications incorporating design improvements, together with product engineering will be carried out by Raytheon-Canada Ltd.

The General Electric Research Laboratory has discovered a method of producing semiconductor diamonds.

Diamonds are made semiconducting by adding impurities such as boron, beryllium or aluminum to the mixture of graphite and catalyst from which diamonds are made. The mixture is subjected to pressures of about one million psi and temperatures above 2,000 F. All the semiconducting diamonds made so far have been p-type, and a search for processes that will produce n-type diamonds is continuing. In borazon, which has a structure similar to that of diamonds, both p- and n-type crystals can be produced.

Canadian Admiral Corp. Ltd., reports heavy increase in sales of TV sets during August and early September.

For the first time in five years, Canadian Admiral Corp. Ltd. is back-ordered on a variety of TV models as a result of unusually high sales during August. Sales exceeded predictions by well over 20%. President Stuart D. Brownlee said that increased sales are nationwide, and he attributes the increase to the long-awaited TV replacement and second-set market.



Dr. R. H. Wentorf of GE Research Labs with a piece of semiconducting diamond in an electrical test jig.

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Because they're the only transistors in the world produced by full automation. No chance for human error. **Because** every one of them is tested. Not one dud in a million. **Because** every fourth Philco employee works only on reliability. **Because** we log two million hours of transistor life tests a week. **Because** we have already spent over five million dollars solely on a transistor reliability assurance program!

Compare these facts with the production and testing techniques of any of Philco's competitors. Then you be the judge. We think you'll agree that...

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QUEBEC: Canadian Electrical Supply Co. Ltd., 275 Craig Street West, Montreal

NEW BRUNSWICK, NOVA SCOTIA, NEWFOUNDLAND: Commercial Equipment Ltd., King Street, Saint John, New Brunswick

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Transport Department completes appointment of senior officers

The Department of Transport has announced that its most recent appointments are the last in a six-year program under which senior officers in the department have received special training on a rotating basis.

H. J. Williamson, Regional Director, Air Services, Edmonton, has been appointed to the position of Acting Chief of Technical and Policy Coordination in the Telecommunications Branch. He replaces **C. M. Brant** who recently received a two-year appointment as Deputy Director, Air Services (CEE, Aug. 61, p7).

G. E. McDowell has been appointed Acting Regional Director, Air Services, Edmonton. Mr. McDowell, regional aids engineer, Air Services, Toronto, has been acting Regional Director, Vancouver, since 1959, while the Director, **Dr. T. G. How,** was on temporary duty as Deputy Director, Air Services, Ottawa.

S. Edward Franklin, MSEE, BSEE, MBA, has been appointed vice-president - manufacturing, Canadian Aviation Electronics Ltd.

Mr. Franklin has had broad experience in the electronics industry over a period of 20 years. He was previously associated with the Link Division of General Precision Inc., in a senior manufacturing capacity. His headquarters will be at CAE's main plant in Montreal.

Franklin

Sparks

The appointment of G. W. "Ned" Sparks as Ottawa Manager of Technical Products has been announced by RCA Victor Co. Ltd.

Mr. Sparks was born in England and served with the RAF during the last war. He retired from the Service in 1950 with the rank of Flight Lieutenant, Technical, and came to Canada in the following year. He became sales manager for Radio Communications Engineering and Equipment Ltd. and held this position for several years. He later joined Standard Telephones & Cables as contract administrator.

In his new position with RCA Victor, Mr. Sparks will be responsible for negotiating the sale of specialized products and services to Government Departments and Agencies. He will report to Mr. J. A. Collins, Manager, Defence Contracts, RCA Victor Company, Ltd.

Douglas Simpson becomes manager of marketing and product research, and John A. McCrodan becomes Toronto district sales manager for Canada Wire and Cable Co.

Mr. Simpson was previously chief plant engineer at Toronto. Mr. McCrodan has represented the company in a sales capacity in Montreal, Winnipeg, Vancouver and latterly Toronto.

Simpson

Kalfus

J. E. Kalfus has been appointed chief engineer of Essex Electronics of Canada Ltd., a division of Nytronics, Inc.

Mr. Kalfus was awarded a master's degree in science at the University of Toronto in 1954 and has been an electronics development engineer with Canadian General Electric, Pye Canada Ltd. and Philips Electronics Industries Ltd. Associated with the University of Toronto as lecturer in TV engineering, wave guides, microwaves etc., he is now conducting a course on transistors for the University Extension.

Three senior sales appointments have been made by Canadian Admiral Corporation.

Don L. Blackman, for five years branch manager in Vancouver, becomes sales promotion and marketing manager. D. G. Christian is the new manager of the Vancouver sales branch, and G. J. Manolescu replaces Mr. Christian as Calgary branch manager.

Fleetwood Corp. has appointed George Butler sales manager for central and southern Ontario.

Fleetwood's expanded sales organization in Ontario is now supervised by R. Robertson for Northern Ontario, Northwestern Quebec, and the Lakehead; by W. J. Collins for the Ottawa Valley; and by Mr. Butler whose office is located at 34 Kelfield St., Rexdale, Ont.

These appointments and transfers have been made in the Aviation Division of Railway & Power Engineering Corp.

Harry A. Talbot has been transferred to Ottawa where he becomes the Ottawa district representative. He has been with the company for eight years and latterly has served as a technical sales representative in Toronto.

Raymond R. Finney is appointed technical sales representative in the Montreal area. He comes to Railway & Power after five years service with Jarry Hydraulics in Toronto.

Kenneth E. Norwood takes a position as technical sales representative in Toronto. He has been with the company for four years and was previously responsible for aviation activities in Vancouver.

Responsibility for aviation activities in Vancouver is now assumed by **Gordon Marshall** who has been district manager in that area for several years.

Talbot

Finney

Norwood

Thomas

G. W. (Gerry) Thomas has been appointed sales representative serving the Ottawa District for Automatic Electric Sales (Canada) Ltd.

Prior to his appointment, Mr. Thomas was with the company's Toronto Office for a period of seven years.

(Continued on page 56)

LITTON ALL-INERTIAL AUTOMATIC NAVIGATOR INSTALLED IN AN OPERATIONAL FIGHTER

NEW PROOF OF LITTON'S CONTINUING CONTRIBUTIONS TO THE DEVELOPMENT OF INERTIAL NAVIGATION IS FURNISHED BY THE LN-3-2B AUTOMATIC NAVIGATOR THAT IS NOW BEING INSTALLED IN CANADA'S CF-104 FIGHTER.

Three-hundred-and-sixty-degree freedom of aircraft maneuver on every axis is made possible by four-gimbal isolation of the Litton stable platform that keeps the system's accelerometers aligned in inertial space. Voltage signals from the accelerometers are transmitted to a computer where they are integrated to compute vehicle position components.

In addition, an adapter unit provides 27 outputs of pitch, roll and heading angles and ground speed to other equipment in the aircraft such as bombing computer and autopilot.

In flight, tight servo loops hold all sensitive elements of the stable platform at null regardless of acceleration. Any relative motion between the gyro case, which is fixed to the platform, and the floated gyro rotor, which is fixed in space, is sensed and corrected to keep the platform including accelerometers oriented to vertical and north. Any acceleration along an axis produces an accelerometer torquer current which is proportional to the applied acceleration. This torquer current holds the accelerometer at null, and the same signal is transmitted to the navigation computer.

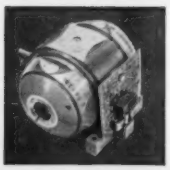
Litton Systems (Canada) Ltd. is playing an increasingly vital role in Canada's CF-104 program. At its Rexdale facility the company is undertaking:

- The manufacture of electronic sub-systems for the LN-3.
- The final test and calibration of the complete LN-3 system.
- The design and manufacture of ground support and other special purpose electronic test equipment.
- The training of R.C.A.F. and industry personnel.
- After-sales service including provision of spares and field representation.
- Maintenance, repair and overhaul.

EXAMINING LN-3 STABLE PLATFORM UNDER TEST AT LITTON'S WOODLAND HILLS, CALIF. FACILITY ARE L-R: VIC SYMONDS, LITTON-CANADA; P. LUTH, LITTON-CALIF.; D. BELYEA, DOP.

These programs are being carried forward by engineers and technicians specializing in inertial navigation and related techniques.

If you have experience in fire control, analog, servo or gyro systems this may be your opportunity to gain further knowledge in this continuously expanding field in Canada with one of the world's leaders in inertial navigation systems. Opportunities also exist for field service representatives and mechanical assembly technicians. To apply, write: Personnel Manager, Litton Systems (Canada) Limited, 123 Rexdale Blvd., Rexdale, Ontario.



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Closed-circuit TV system to be installed at Thompson, Manitoba

The new mining town of Thompson, in northern Manitoba will soon have a pay-TV system. Subscribers will receive locally-produced film and live program TV service through a closed-circuit hook-up, rather than through a main television station or rebroadcast operation.

The "station" will generate its own television pictures locally, but will distribute the signals by cable.

Canadian Engineering Surveys Ltd., Edmonton, is setting up the system and will charge a connection fee plus monthly rental to subscribers. The company has contracted with Canadian General Electric Co. to supply some $75,000 worth of equipment and cable distribution facilities. Included are two vidicon cameras, two film projectors, a slide projector, tape recorders, sync. generators and switches. CGE will supply a Jerrold Electronics distribution system.

Although the system must be cleared by the Department of Transport, the operation is not subject to Television Broadcasting regulations at this time.

South American airline buys Canadian doppler navigator

Real Aerovias Nacional(REAL Airlines), Brazil, has placed an order with Canadian Marconi Co. for Doppler navigation equipment to be fitted into its new Convair jet aircraft. This brings to 10, the number of major international airlines who have installed this equipment.

Trans-Canada microwave expands facilities for CTV Television

The Trans-Canada Telephone System is expanding its microwave facilities to provide service for the new CTV Television Network Ltd.

Under terms of an agreement between CTV and Trans-Canada Telephone, CTV will pay an annual rental which will increase progressively as new facilities are installed. Total amount of the contract is estimated to be in excess of $11,000,000 for the life of the contract — 1968.

At present, private TV stations in Halifax, Montreal, Ottawa, Toronto, Winnipeg, Calgary, Edmonton and Vancouver are charter members of CTV. Other stations may join the network full, or part time.

The microwave facilities presently installed permit simultaneous telecast between Montreal, Ottawa and Toronto. Other areas are served by transmitting and recording during the off-hours. Completion of the additions to the microwave system will permit simultaneous transmission of the CTV signals in both directions from Vancouver to Halifax.

Target date for modifying the Toronto-Vancouver section is Sept. 1962; for the Montreal-Halifax section it is June 1963.

New principals, representatives and services

New Electronic Products Ltd., London, England, recently became an affiliate of Honeywell Controls Ltd., **Radionics Ltd.,** which has been representing N.E.P. in Canada, will continue to do so. In addition, it has been authorized by Honeywell to distribute the latter's line of Visicorders.

Electronic Controls Ltd., Belleville, Ont., has been appointed Canadian sales representative by **Electronic Measurements Co. Inc.** The product line is regulated dc power supplies.

Granger Associates of Palo Alto, Calif., manufacturers of antennas and matching devices, has appointed Instronics Ltd., Stittsville, Ont., as its Canadian representative.

The Glendon Instrument Co., Scarborough, Ont. has been appointed Canadian sales representative by **Chrono-log Corp.,** Philadelphia, manufacturers of digital clocks, calendars and timers, and a step system for TV automation.

Canada Wire and Cable Co. Ltd., Toronto, has been appointed exclusive sales agents for Copperply communications wire in Canada. The wire is manufactured by **National-Standard Co. of Canada, Ltd.** at its new plant in Guelph, Ont.

Representation in British Columbia for **Metex Electronics Corp.,** Clark, N.J., has been undertaken by Seatronics, Inc., 1817 Mormon St., Seattle.

Burroughs enters punched-card computer business

Burroughs Business Machines Ltd. has introduced a series of punched card electronic computing equipment. The series includes the basic B260 punched card computer system; the B280 magnetic tape system; and the B250 system which incorporates a hard-copy record processor in addition to punched card handling equipment.

(Continued on page 56)

Ottawa report

New companies manufacturing a broad range of electrical and electronic products were established during the first half of this year at a rate indicating a 12-year record may be set in 1961.

A survey by the Bureau of Statistics shows that 19 new manufacturing companies of this type set up shop for the first time during the period January-June, compared to 30 for all of 1960 and a record of 37 new establishments in any year between 1950 and 1960.

Included are firms which "came into operation recently or report they expect to be in operation in the near future".

The record for new establishments:

Yearly average (1950-1960)	27
Peak year (1954)	37
1959	30
1960	30
First half 1961	19

Size of establishments:

Less than 5 employees ..	78
5 to 50 employees	173
More than 50 employees	41
Total (1950-1960)	292

New firms in 1961:

Among the new companies established in 1961 are: V.H.F. Electronics Ltd., 37 Courtney Drive, Montreal; Fromac Industries Ltd., Vankleek Hill, Ont.; Western Television Laboratories Ltd., 1612-14th St., Saskatoon (TV picture tubes); Caltron Manufacturing Co. Ltd., Box 1034 Lethbridge, Alta. (TV picture tubes).

Make sure you have approval of Underwriters' Laboratories Inc., before selling in the United States or you'll run into costly delays and disappointments.

The Department of Trade and Commerce reports that "Canadian manufacturers who wish to sell in the U. S. are not always aware until quite late in their promotion campaign that their products have to be approved by UL before leading marketing organizations will handle them."

In certain states UL approval is necessary before products can be marketed.

The department states "although a sample may be sitting

(Continued on page 56)

a *Genie* at your command—

the CALL director

The 30-button CALL director helps secretaries handle more calls, streamlines office operation.

From Northern Electric comes a new-style genie . . . the CALL director telephone. It's the versatile virtuoso of modern business communications. To reach many inter-office extensions—just press a button. To hold a telephone conference—just press a button. To connect outside calls to others—just press a button. The CALL director is available with 12, 18 or 30 buttons and many features to save precious business time.

The CALL director telephone is another step forward in the science of business communications by Northern Electric, who design and manufacture most of Canada's telephones and related equipment.

Northern's extensive experience in this field, along with their creative engineering and design personnel and modern manufacturing facilities are at your command. Branches are strategically located across Canada to serve you.

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COMPANY LIMITED

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2060-5

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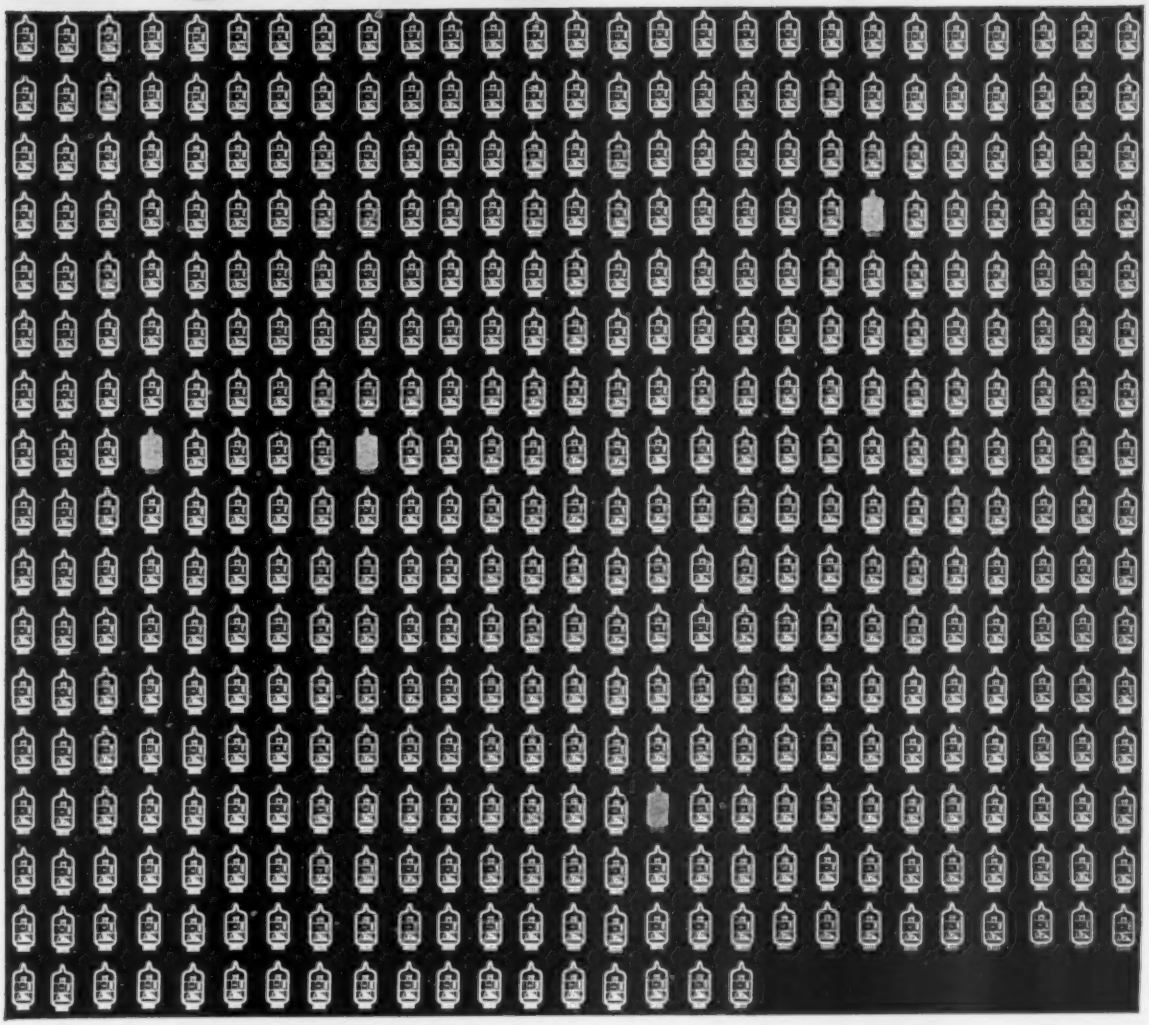
LONG LIFE



G-E 5-Star tubes prove 99.11% reliable in 10,000 hour life test

Four hundred and fifty type 6829 Five-Star tubes were subjected to a DC life test to study the effects of heater voltage, heater-cathode potential and plate dissipation on vacuum tube life and reliability. Only four failures occurred despite the fact that the test parameters were purposely made severe enough to encourage early failures.

Outstanding performance such as this is proof that the longer service life and ultra-reliability of G-E 5-Star tubes will protect your reputation by increasing the performance and dependability of the equipment you build. *Five Stars are not tubes selected from standard receiving types.* They are specially designed, specially manufactured to cope with particular electrical requirements and to withstand severe environmental conditions such as shock and vibration. Where you can't afford to comprise performance and reliability be sure to specify G-E 5-Star tubes. For full information contact: Electronic Tube Section, Canadian General Electric Company Limited, 189 Dufferin St., Toronto, Ont.

INDUSTRIAL AND MILITARY TUBES

TAD-2037-861

ELECTRONIC TUBE SECTION

CANADIAN GENERAL ELECTRIC COMPANY LIMITED

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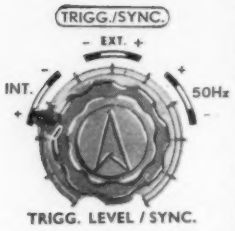
broad-band oscilloscope

with differential

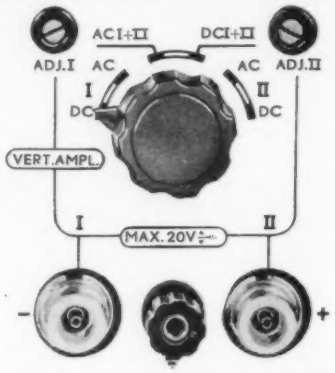


Trigger–Sync possibilities

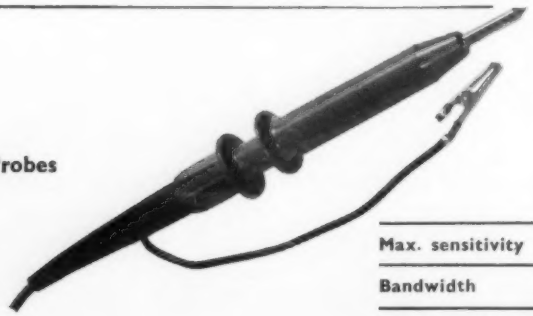
Due to the sensitive and highly stable trigger circuit operation is extremely simple. The delay-line incorporated in the vertical amplifier, and the excellent properties of the trigger circuit, enable pulses with a long rise time to be reproduced completely.
Triggering: up to 2 Mc/s (at 5 mm amplitude)
Synchronisation: up to over 14 Mc/s

DC-coupled differential amplifier

The two inputs can be used either separately (asymmetrically) or in combination as a differential input.
Bandwidth DC - 14 Mc/s (AC coupled from 1 c/s upwards)
Sensitivity 50 mV/cm
Rejection factor between 250 and more than 1000 depending on frequency and input voltage.
Special input plugs enable quick exchange of probes and measuring cables. The cathode-follower probes are fed from the oscilloscope via the same plugs.



Probes



Two attenuator probes and two DC-coupled cathode-follower probes are included in the delivery. Two screwcaps per cathode-follower probe enable AC coupling with different bandwidth and input capacitance.

	Att. probe	Cathode-follower probe		
		DC	AC(HF)	AC(LF)
Max. sensitivity	500 mV/cm	50 mV/cm	50 mV/cm	50 mV/cm
Bandwidth	0-14 Mc/s	0-14 Mc/s	100 c/s-14 Mc/s	1 c/s-14 Mc/s
Input impedance	10 MΩ//7 pF	0.5 MΩ//5.5 pF	0.5 MΩ// 7 pF	0.5 MΩ//10 pF

PHILIPS *electronic measuring*

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Further information will gladly be supplied by:

Philips Electronics Industries Ltd.,
116 Vanderhoof Ave., Toronto 17, Ont. - Montreal: 8525 Decarie Blvd.

GM 5603

input

Main specification

5" C.R.T. with 10 kV accelerating voltage

DC coupled differential amplifier up to 14 Mc/s

Sensitivity 50 mV/cm

Sweep speeds between 40 mμsec/cm and 2.5 sec/cm

3% accuracy for vertical deflection and sweep speeds

A complete set of accessories and instructions for maintenance and service are delivered with the instrument

instruments: quality ***tools*** for industry and research

PHILIPS

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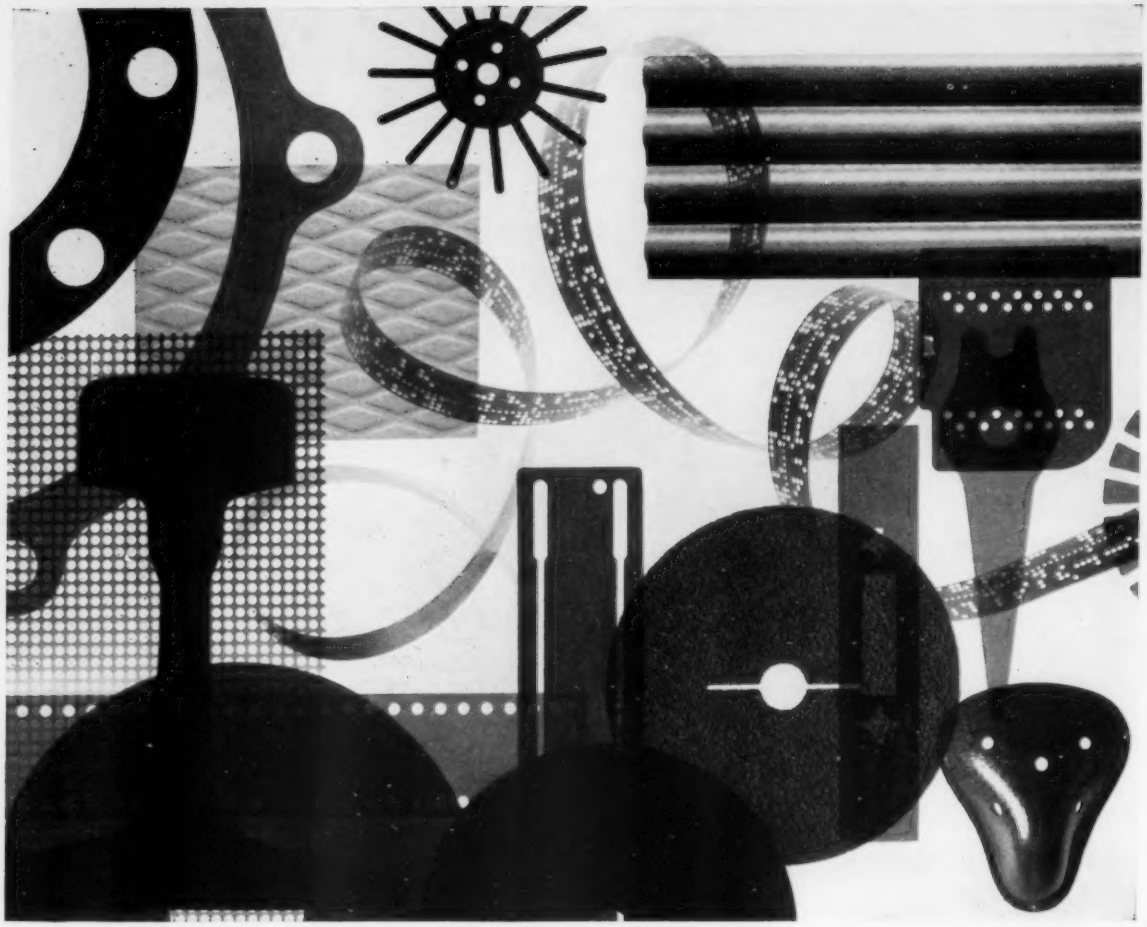

Consider the many ways this plastic can toughen your product, lighten your problem

National Vulcanized Fibre is one of the most do-more, save-more, get-around materials ever produced. Thousands of jobs well done have established its reputation. Yet there are still other cost-cutting applications to be explored, many that no other plastic can handle.

What is Vulcanized Fibre? A tough, dense cellulosic plastic. As track insulation, thousands of tons of Vulcanized Fibre are now absorbing the steady beating of trains passing over. Has the highest arc resistance of any material known; is a class "A" electrical insulation. Low thermal conductivity, high resiliency, great shock and abrasive resistance. Shrugs off oil, gasoline, most solvents. A most un-ordinary plastic. Weighing but half as much as aluminium, Vulcanized Fibre is one of the strongest of materials for its weight.

You can machine, punch, form, deep-draw; combine with rubber, copper, laminated plastic, and other materials. Takes polish, paint, embossing. Consider design and shape . . . you'll find Vulcanized Fibre as motor slot insulation or in intricate forms such as gear assemblies.

There are 16 standard and many special grades, among them "Pyronil", which is fire-resistant. You may find precisely the properties needed to make your product a better buy. There's a free sample kit waiting for you at the nearest National sales office. Or write directly, Dept. II-10, Toronto, Ontario.

116 Choices: One Source This is the latest count of the different plastics and grades National can offer in your search for the *one best material*. Add to this total *the* one special grade that can be developed from scratch to meet your particular need. This full range of materials is backed by complete engineering services . . . from application assistance up to and including the delivery of Canadian made, 100% usable, precision-fabricated parts . . . in any quantity, on time!

Call the National Sales Office near you. It's a direct line to single-source help on your current materials problem.

NVF

NATIONAL FIBRE CO. OF CANADA

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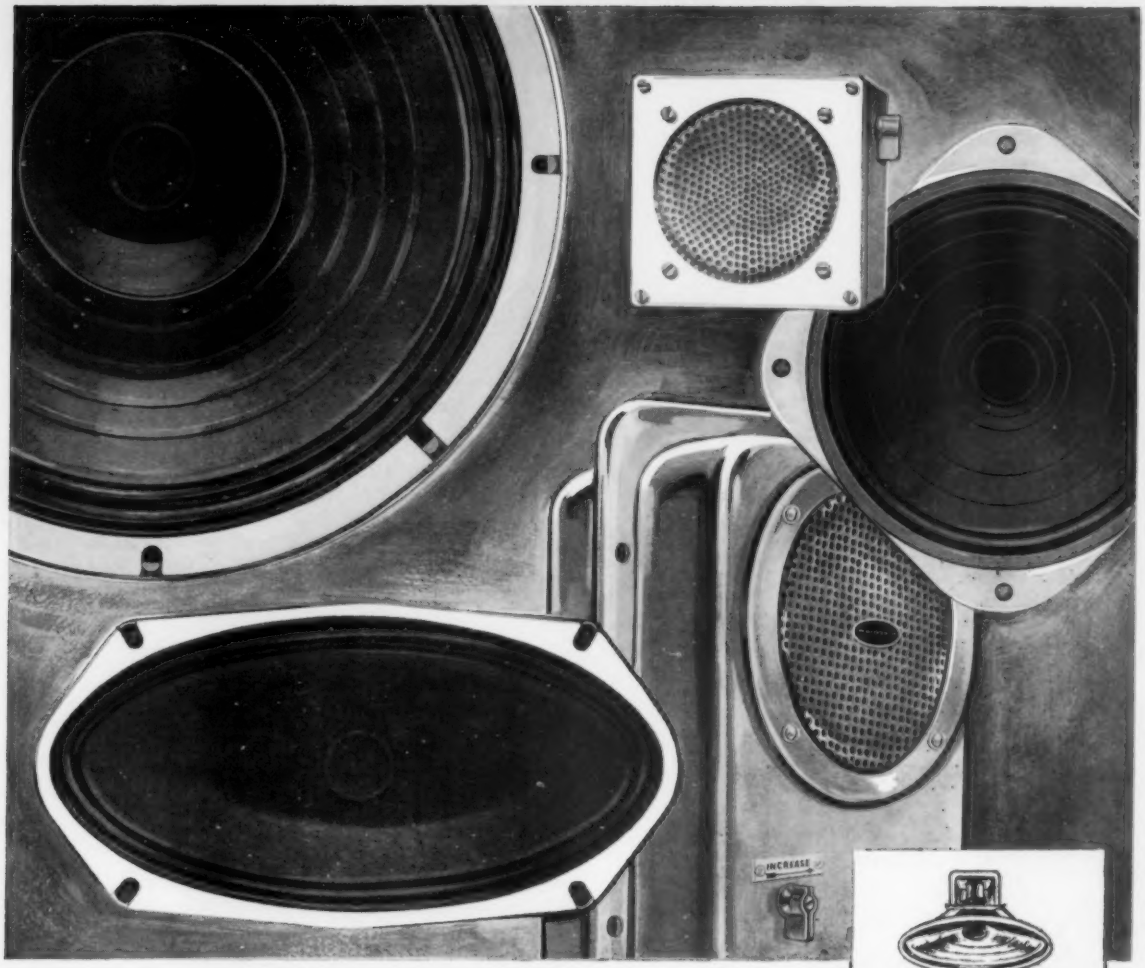

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- **SPECIALS BUILT TO ORDER**

Marsland permanent magnet loudspeakers are manufactured in round, square and elliptical shape and in sizes from 2″ to 12″, with all conventional Alnico 5 magnet weights in the magnetic structure.

Standard lines provide voice coil diameters of 9/16″, 3/4″ and 1 1/4″ with impedances of 3.2 and 6 ohms. Higher impedances up to 45 ohms are available to special order.

Marsland has built millions of economical, high quality loudspeakers suited to all types of commercial applications. Stock models include: the "Imperial" line, particularly noted for faithful sound reproduction; moisture-proof models for outdoor or special inside installations; blast-proof speakers and enclosures for specialized tasks in industry and for military applications.

Detailed Information Available On Request

Single Speakers

Elliptical Automotive Speakers

Combination Speakers

Blast-proof Speakers and Enclosures

MARSLAND LOUDSPEAKERS

M/5

MARSLAND ENGINEERING LTD. KITCHENER, ONTARIO, CANADA

Associate Company

MARSLAND PRECISION EQUIPMENT LIMITED WATERLOO, ONTARIO

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Choose 'SQUARETRIM' precision potentiometers for any purpose from Canada's most complete line...

even under these conditions...

We'll admit a goldfish bowl is a peculiar place to use a precision-built, wire-wound, sub-miniature potentiometer . . . but, "even under these conditions," the HUMIDITY PROOF Series 300H Trimming Potentiometer will operate with complete reliability.

Now made in Canada, the Series 300H offers complete protection against humidity and moisture without sacrificing the other environmental and performance specifications. The Daystrom Series 300 is accepted everywhere as THE outstanding Trimming Potentiometer.

- **Finer Resolution**
- **Higher Power Rating**
- **Better Stacking (20 units in less than one cubic inch)**
- **Greater Reliability under the most adverse environment**
- **Made in Canada**

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WE BROKE A DOZEN SCREWS, BUT

we couldn't make this sheet metal insert spin in its hole!

THE INSERT PROBLEM

A hole punched in thin sheet metal doesn't provide enough surface for threading. You often have to supply the threads by installing an insert.

But the same hole doesn't provide much surface for *gripping*, either. The insert spins.

WHAT WE DID ABOUT IT

The insert we tested was designed with an *angular* knurl around a cone-shaped gripping perimeter. Here's what happened:

First: When we mated the sheets, put in a screw, and tightened it in the insert, the screw pulled the insert toward the sheet. It also pulled the teeth of the angular knurl more firmly into the edges of the hole, increasing their resistance to spin.

We broke screws (No. 8, 10, 12, and 1/4 sizes) by overtorquing them. But the only effect on the insert was to tighten it.

Second: When the insert was first pressed into the hole, the angular knurl displaced metal, squeezing it toward and into a groove around the bottom of the insert. This locked the insert against being pushed out before the screw was tightened. After tightening, the lock was intensified by the added squeezing pressure of the angular knurl.

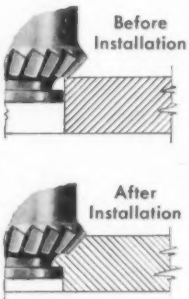
WE'LL SEND SAMPLES

If you've had this insert problem, drop us a line on your letterhead. We'll send some Southco THREDS (that's their name) for you to try. No obligation, of course.

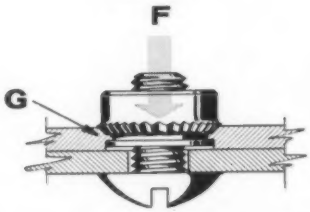
THREDS . . . AND THE ANGULAR KNURL PRINCIPLE

Southco THREDS are installed by pressing into a single hole in the sheet, provide thread length equal to or greater than that of a standard nut. One insert fits any sheet thickness (see minimum requirement, last column in table below). Material is case hardened steel, Cad. plated per Fed. Spec. QQ-P-416 Type II, cl. 2, yellow iridite.

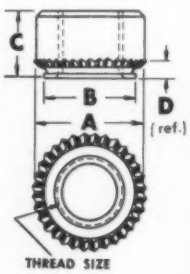
ANGULAR KNURL
(detail)



Teeth bite into edge of hole, force metal into locking groove at base of insert.



Additional torque on screw increases force F, pulling teeth of angular knurl more firmly against sheet and putting extra pressure on metal in locking grove G.



SOUTHCO THREDS[T.M.] . . . SPECIFICATIONS

THREAD SIZE	PART NUMBER	A	B	C	D	Weight per M (lbs.)	Min. Sheet Thickness
4-40 NC	74-11-104-13	7/32	.185	5/32	3/64	1.22	.036
6-32 NC	74-11-106-13	9/32	.247	5/32	3/64	1.99	
8-32 NC	74-11-108-13	5/16	.278	3/16	3/64	2.87	.048
10-24 NC	74-11-110-13	5/16	.278	3/16	3/64	2.51	
10-32 NF	74-11-210-13	5/16	.278	3/16	3/64	2.53	
12-24 NC	74-11-112-13	13/32	.372	3/16	1/16	4.56	.060
1/4-20 NC	74-11-125-13	13/32	.372	3/16	1/16	4.28	
1/4-28 NF	74-11-225-13	13/32	.372	3/16	1/16	4.32	

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METAL AND WOOD FASTENING DEVICES
302 King St. East
Toronto, Ont.

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at Canadian Marconi

factory tested and sealed

Before they leave the factory, all Marconi Image Orthicons undergo extremely critical testing.

studio conditions duplicated

Acceptance tests are conducted when the tubes arrive in Canada. Marconi has built a special lab where the image orthicons are tested under Canadian studio conditions.

fast warranty

This special testing lab enables Marconi to offer immediate warranty adjustment when required.

"total" testing

An extensive series of tests check every detail. Once it has passed these tests, the camera tube is shipped to the studio, sealed and protected by the Marconi guarantee.

visiting studio personnel

Studio engineers and technicians are invited to inspect and make use of these facilities.

tests vary

Each of the six types of image orthicons undergoes its own special tests. To test each tube thoroughly takes 30 to 50 minutes.

the only complete Image Orthicon testing lab in Canada

ELECTRONIC TUBE AND COMPONENTS DIVISION

CANADIAN Marconi COMPANY

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When should you use Mercury-Wetted Contact Relays?

IF YOUR RELAYS MUST

SWITCH UP TO 100 TIMES PER SECOND

HAVE A LIFE IN EXCESS OF A BILLION CYCLES

BE COMPLETELY RELIABLE AND FREE FROM CONTACT BOUNCE

THEN SPECIFY P&B MERCURY WETTED CONTACT RELAYS

An unusual combination of advantages found only in mercury-wetted relays has led many design engineers to specify them for tough switching jobs. Here are but 3 typical characteristics of our JM series:

RELIABILITY. Sealed-in-glass mercury contacts are renewed with every operation. Won't pit or weld. Make or break is positive . . . every time. No bounce, no chatter. Signals ranging from a few micro amps to 5 amps are switched with singular consistency.

LONG LIFE. Think in terms of *billions* of operations when considering JM series relays. Proper application, of course, is a requisite.

SPEED. Operate time is just less than 3 milliseconds using 2 watts of power. Release time is about 3.2 milliseconds. Thus, relays can be driven 100 times per second.

If your project calls for exceptional relay performance, perhaps the answer lies in our JM Mercury-Wetted contact relay.

JM SERIES ENGINEERING DATA

Contact Rating:
5 amperes maximum
500 volt maximum
250 volt-amp max. with required contact protection.

Contact Configuration:
Each capsule SPDT. Combination of capsules in one enclosure can form DPDT, 3PDT, 4PDT. (All Form D.)

Terminals:
Plug-in or hook solder; 8, 11, 14, or 20-pin headers.

Coil Resistance:
2 to 58,000 ohms.

More information?
Write today for free catalogue.

P&B STANDARD RELAYS ARE AVAILABLE AT YOUR LOCAL ELECTRONIC PARTS DISTRIBUTOR

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Snap-in removable crimp contacts

FROM THE ORIGINATOR OF THE GOLDEN-D

CANNON SUBMINIATURE GOLDEN-D MARK II

Golden-D Mark II Subminiature, the crimp snap-in version of the famous "D" line, is available for immediate delivery! ■ MATES WITH ORIGINAL D ■ MONOBLOC INSULATORS ■ SNAP-IN REMOVABLE CRIMP CONTACTS DESIGNED TO MS 3190 ■ CADMIUM PLATED, GOLD IRIDITE FINISH SHELLS ■ FIVE SIZES WITH 9, 15, 25, 37, and 50 CONTACTS ■ PROBE-PROOF CLOSED ENTRY SOCKET CONTACTS ■ LOW ASSEMBLY COST FOR THE USER. Wherever maximum reliability is needed in a subminiature multicontact plug—for both military and industrial applications—specify the Golden-D Mark II...*it is engineered to deliver superior performance by the world's most experienced manufacturer of electrical connectors.* Write for D-8 Catalog.

CANNON PLUGS

CANNON ELECTRIC CANADA LIMITED 160 Bartley Drive, Toronto 16, Ontario

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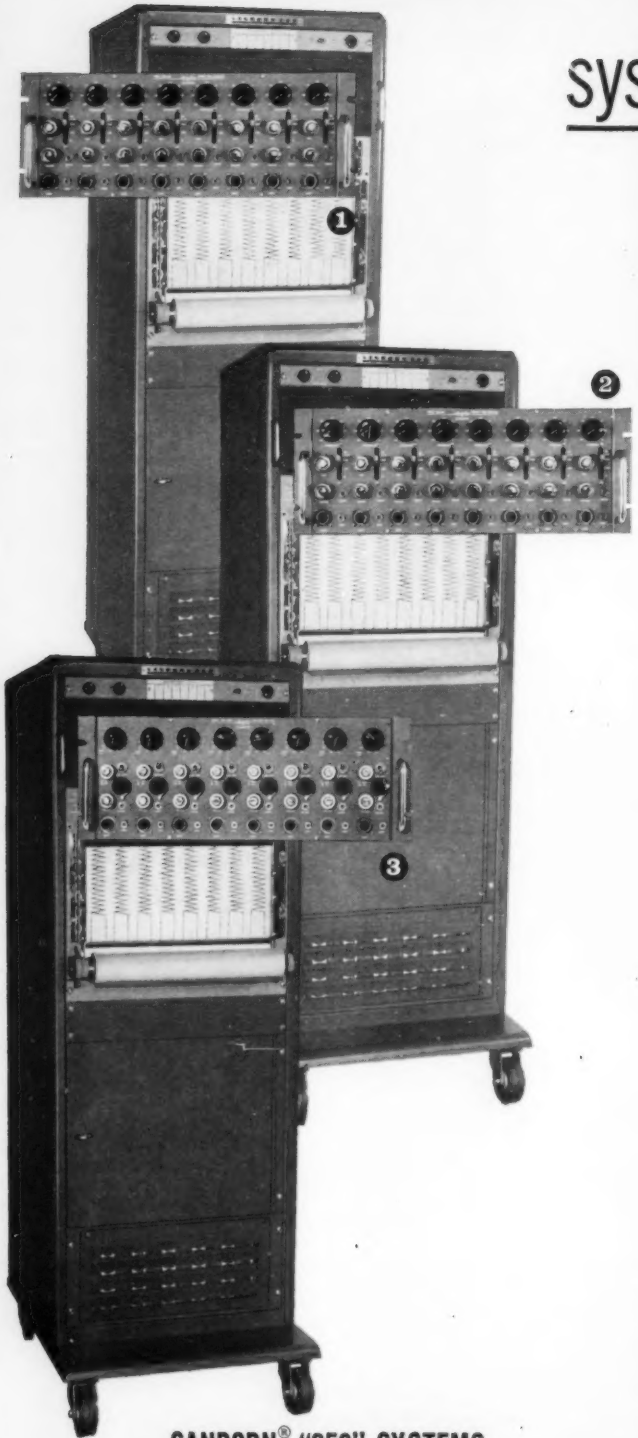
match system sensitivity to your recording application



When your recording application calls for 6 or 8 direct writing, general purpose channels with identical sensitivity and input electronics, Sanborn "950" design provides a highly useful, economical answer in the precise sensitivity range you need. Choices include systems with:

1 HIGH GAIN AMPLIFICATION . . . 6 or 8 transistorized channels with floating and guarded inputs, 100,000 ohms resistance on all ranges, 10 to 2000 uv/div sensitivity. System response DC to 100 cps within 3 db at 10 div peak-to-peak amplitude. Common mode performance ±200 volts, max., rejection 140 db min. at DC. High gain stability, max. non-linearity 0.5%, low noise and drift. All channels have range, gain, function, position and galvanometer frequency compensation controls.

2 MEDIUM GAIN AMPLIFICATION . . . 6 or 8 transistorized channels with floating and guarded inputs; ½ meg. resistance on mv ranges, 1 meg. on volt ranges; sensitivity 0.5 to 20 mv/div and volts/10 div. System response DC to 150 cps within 3 db at 10 div peak-to-peak amplitude. Common mode voltage ±500 volts, max., rejection 140 db min. at DC. Same controls as High Gain amplifier.

3 LOW GAIN AMPLIFICATION . . . 6 or 8 channels, balanced to ground inputs 5 meg. each side; tube and transistor circuitry; sensitivity 10 to 500 mv/div and 1 to 10 volts/div. System response same as Medium Gain system. Common mode performance ±2.5 volts and 34 db min. rejection on most sensitive range. Amplifier available with or without Calibrated Zero Suppression.

All "950" systems have 350-style 6- or 8-channel flush-front, heated stylus recorder, using Sanborn rectangular-coordinate Permapaper.® Nine chart speeds, timer/marker stylus, built-in paper take-up. Systems housed in 63⅜" high mobile cabinets; amplifier and recorder occupy only 24½" of panel space. For complete descriptive literature and application assistance, call your Sanborn Industrial Sales-Engineering Representative; offices throughout the U. S., Canada and foreign countries.

SANBORN® "950" SYSTEMS

Dynamic demonstrations of 950 Systems and other Sanborn oscillographic recording equipment at WESCON, Aug. 22-25 Booths 2014-2016

INDUSTRIAL DIVISION
SANBORN COMPANY
175 Wyman St., Waltham 54, Mass.

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Bendix PYGMY® ELECTRICAL CONNECTORS

MIL-C-26482 Type Connector

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2. Readily available.
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5. Satisfies 95% of all connector applications.

MIL-C-26636 Type Contact

6. Use MIL-approved crimp tools.
7. Positive reliability.
8. Maintenance and design flexibility.
9. Easily adapted to automated production.
10. Standardized user production tooling.

MIL-C-26482 and MIL-C-26636

11. No system redesign.
12. Big savings from adaptability to present equipment.
13. Automatic phase-in.
14. Solder option.
15. Competitive pricing.

Interchangeability, reliability, and availability are yours at minimum cost with this new, simplified Bendix Connector Combination. Check into it. We're sure you'll find profitable use for this latest development in our continuing program to provide both military and industrial users with the latest and best in electrical connectors.

The Bendix Corporation Canadian Affiliate

AVIATION ELECTRIC LIMITED

200 LAURENTIEN BLVD., MONTREAL

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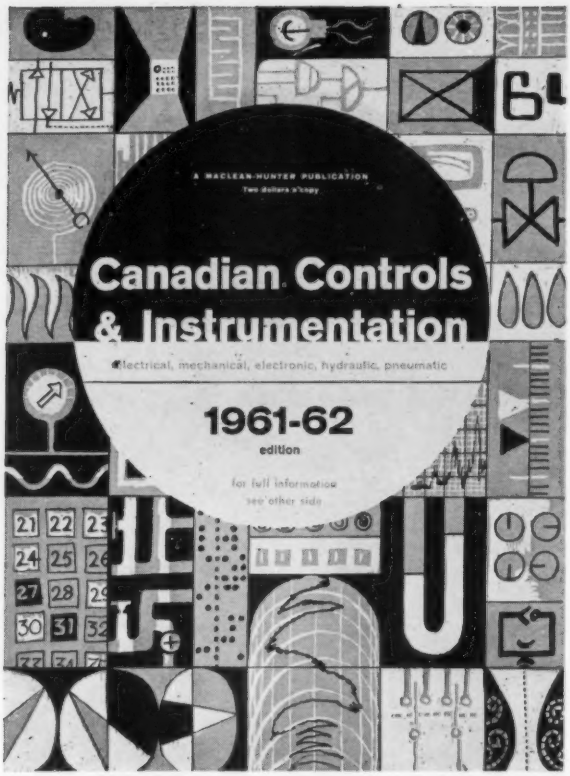

In November 1961, Maclean-Hunter Publishing Company will publish its first edition of a new business publication — CANADIAN CONTROLS & INSTRUMENTATION.

This first issue will present a broad review of the current status and future trends in controls and instrument design, manufacture and application in Canada.

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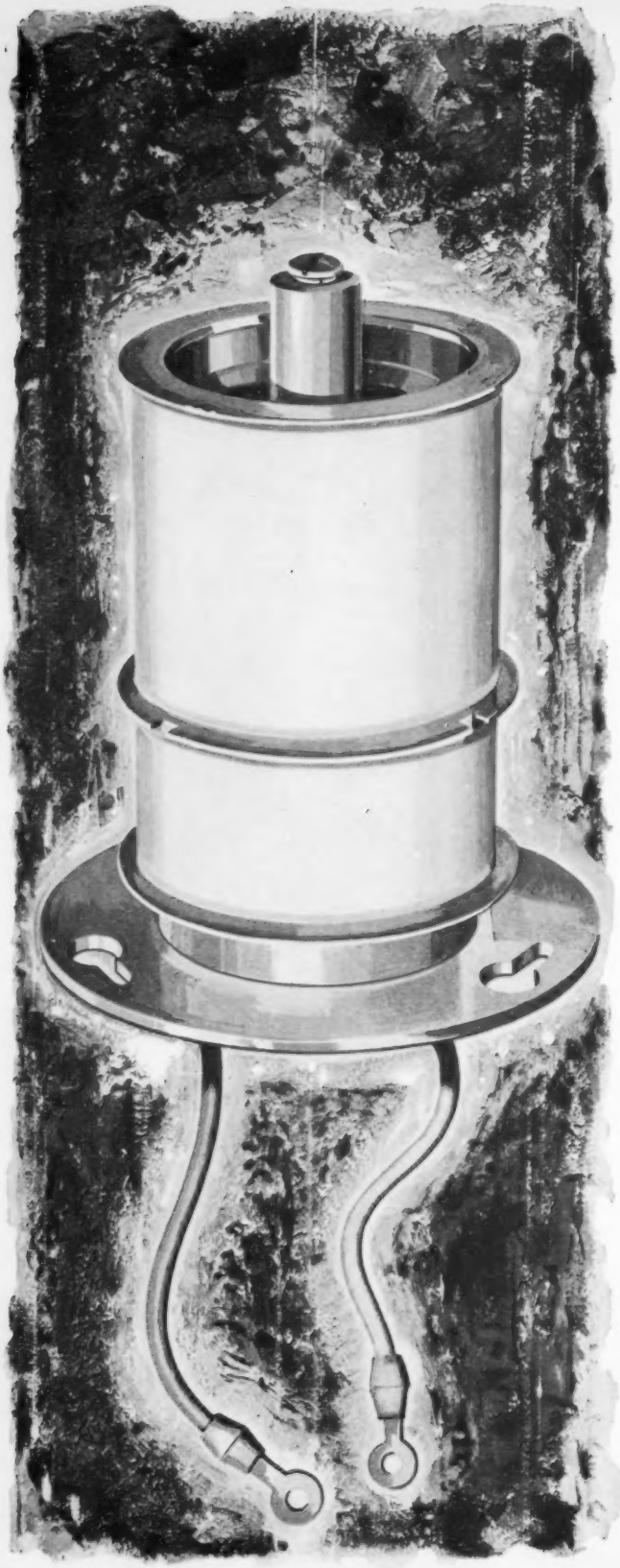

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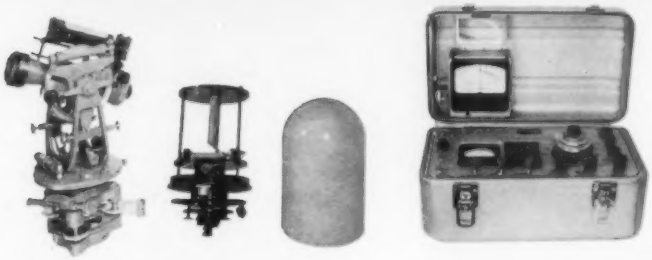

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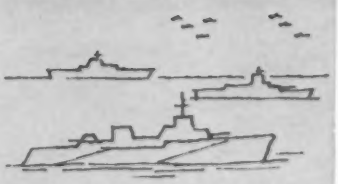

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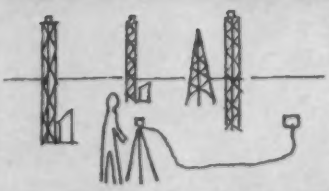

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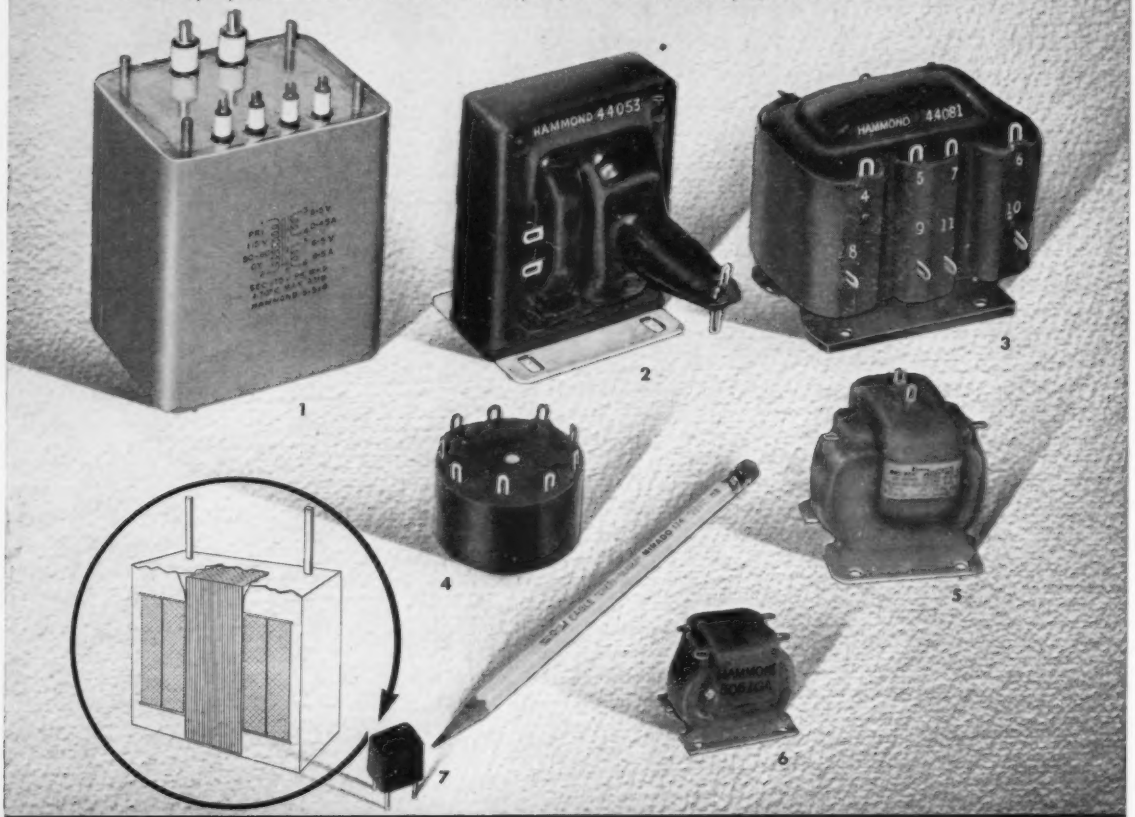

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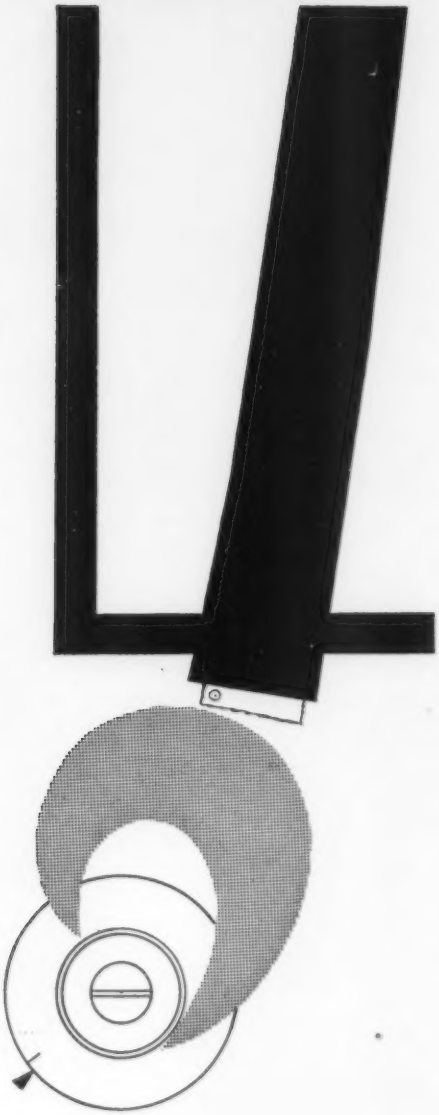

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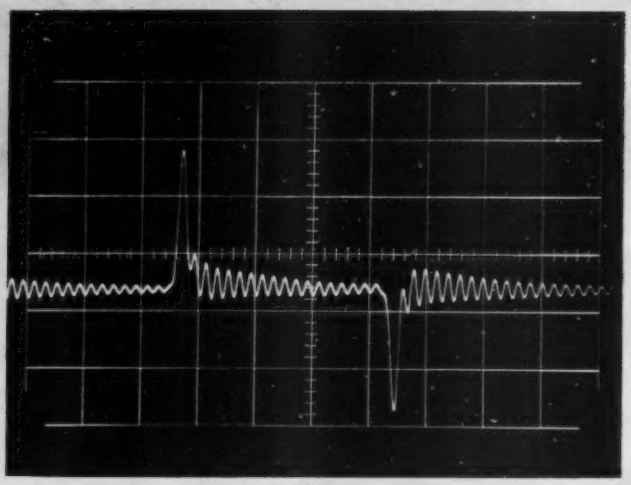

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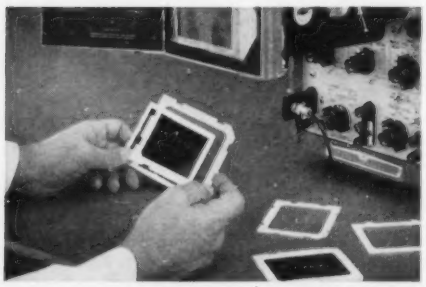

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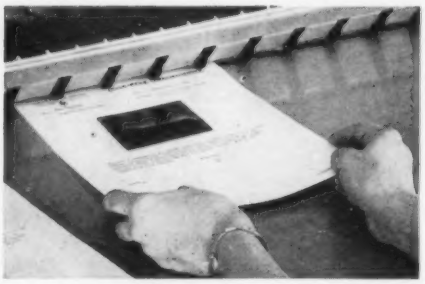

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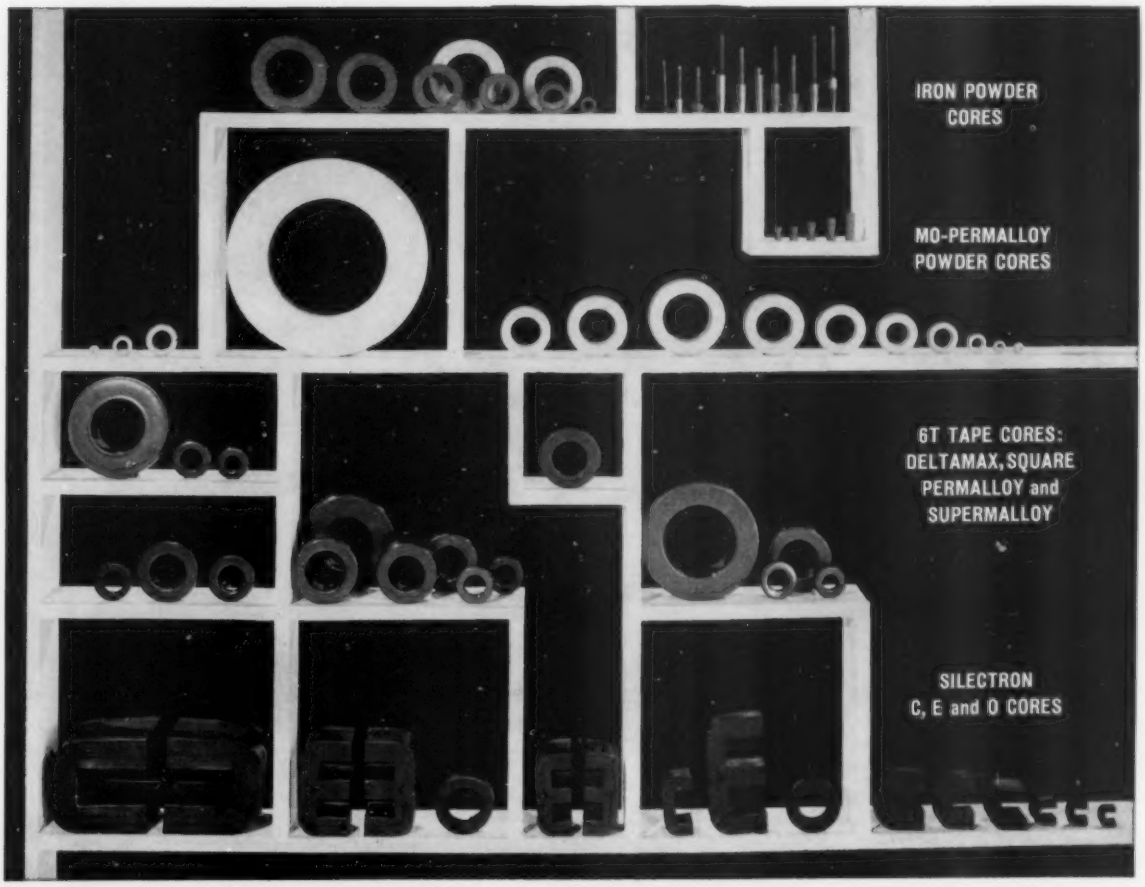
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Electronic Industries Association forms committees to study research, exports

The Electronic Industries Association of Canada has announced the formation of two new committees to deal with research and exports.

An Ad Hoc Committee on Research and Development has been formed to survey all aspects of R&D, including applied research in Canadian industry. Comparing findings with what is being done in other countries will enable the committee to recommend steps which are required to protect the future of the industry in Canada.

Chairman of the research committee is A. B. Hunt, vice-president, research and development of Northern Electric Co. Ltd. Other members are Dr. J. R. Whitehead, director of research, RCA Victor Research Laboratories, and J. E. Smith, vice-president of Computing Devices of Canada Ltd.

The research committee reports to the Government Liaison Committee of E.I.A.

The Export Committee, which is a standing committee of the Electronics Division, is under the chairmanship of W. R. Bitcheno of Canadian Marconi Co. Serving with him are C. E. Woolgar of Northern Electric Co. Ltd., P. W. Larsen of Canadian Applied Research Ltd., A. Robertson of RCA Victor Co. Ltd. and W. Baillie of Canadian Marconi Company. J. W. Williams, Northern Electric Co. Ltd., is an alternate member.

The committee will be concerned with providing information to member companies on matters pertaining to export business.

Ad Hoc Committee on Research and Development

There was a time in human history when motivation for scientific research was purely the curiosity of man and his aspirations to know the nature of things beyond the frontiers of human knowledge. Today, this peaceful pursuit has developed into a frantic race, pressing for technical supremacy, which has involved industry and commerce. We are engulfed in a technological explosion.

New technology is one of the major factors responsible for the mounting velocity of our foreign competition. Research, therefore, should play an important part in meeting the challenge which faces the electronic industry in Canada. Many of the scientific advances in the United States, Great Britain, and other countries, have been promoted through industry by financial government support. Statistics show that 57% of industry's research and development in the United States is financed by the Government; in Canada it amounts to 21%. In the United States, the Government utilizes industry's facilities to the extent of three dollars for every dollar spent within its own establishments. In Canada, Federal expenditures through industry amount to less than 18c for every dollar spent within its own establishments.

Dr. Steacie, in his annual report of the National Research Council, in comparing industrial research expenditures in Canada relative to those in the United States and Great Britain, stated that "To maintain its position as an advanced industrial country, Canada must allocate to

A. Brewer Hunt, chairman of the Committee on Research and Development, is vice-president, research and development, Northern Electric Co. Ltd. He has been with the company since his graduation from the University of Toronto in 1928 with the degree of BASc. In 1954 he went on loan to the Government for a period of 18 months as Director of the Electronics Branch of the Department of Defence Production. Mr. Hunt is a retired Commanding Officer of the 11 Signals Regiment (Reserve), and a past president of EIA. In 1946 he was awarded the Ross Memorial Medal of the Engineering Institute of Canada for his paper, "The future of radio communications in Canada."

scientific research and development a proportion of our resources comparable to that allocated by other advanced countries," and he concluded his remarks on this subject by stating "some way must be found to induce industry to devote more of its resources to research."

The Board of Directors of the Electronic Industries Association of Canada recently set up a special Research Committee to co-ordinate these activities and to assist industry in meeting the challenge cited by Dr. Steacie.

This new Research Committee will act in an advisory capacity on all matters relating to industrial research. It is charged with the responsibility of keeping the members of EIA informed of research expenditures by industry and government and recommending ways and means of stimulating in Canada a more favorable climate for the promotion of research. The recent tax concessions relative to scientific research activities are encouraging to the industry, but the Association feels that a more realistic program of government financial support is required if Canada, as an industrial power, is to measure up with the other leading nations of the world. Industry is not looking for financial grants or "handouts" just to say we are doing research. Instead, there should be a co-ordinated program with government so that industry can be brought in at an early stage on applied research and product development on the projects being carried out by the government research establishments. Projects stimulated by industry should also be given favorable consideration by the Government, if they are of national importance. — *A. Brewer Hunt*

Dr. J. Rennie Whitehead graduated from Manchester University in 1939 and worked with the Radar Research Establishment during World War II. In 1946 he went on loan to Cambridge University as an electronics consultant, and earned his PhD there in 1949. He came to Canada in 1951 to join McGill's Eaton Electronics Research Laboratory. RCA Victor appointed him director of research in 1955.

James E. Smith joined Computing Devices of Canada in 1953 after four years as a research officer in aerodynamics at the National Research Council. From 1958 to 1960 he worked on technical and marketing assignments with Canadian Pratt and Whitney. He returned to CDC in 1960 as vice-president. Mr. Smith graduated from the University of British Columbia with an Honours BASc. in mechanical engineering.

Standing Committee on Exports

In an exclusive interview with Gordon Duffy, Montreal Editor of CEE, this is what W. R. Bitcheno, chairman of the Export Committee of the Electronics Industries Association of Canada had to say on the activities of his committee.

"The export committee was, I suppose, born of my own enthusiasm. I voiced my thoughts at one of the sessions and found myself as chairman of the new committee.

"Actually, the electronics industry in Canada is naturally directed to exports. We must export to survive. There are far too many electronics firms in Canada for the market and, if we are to grow and prosper, we must look to the world market.

"However, the equipment we are to sell abroad must be special. With our high cost of labor and other high fixed costs, we cannot hope to compete effectively on pieces of equipment that are more or less standard. We must place our hopes on original design in electronic equipment which has a definite edge over other equipment in either design, performance or application.

"And it can be done. Although our own (Marconi) doppler navigator has received the most attention, we have sold electronic equipment in this and the communications field to some 26 countries over the past three years or so.

"It is true that when we started, Canada was an unknown name in the world electronics market. We were not known and for some time had to fight the 'new boy' attitude. This now has, I believe, been successfully overcome.

"But reputation is very important. And the way to build a reputation is not only to build reliable equipment — but to also keep your promises on deliveries.

"In Canada nine companies have expressed keen inter-

(Continued on page 41)

Bitcheno

Baillie

Williams

Correction of non-linear distortion in transistor amplifiers

G. W. HOLBROOK, P.ENG.* & E. P. TODOSIEV, P.ENG.†

In recent correspondence[1] it has been shown that substantial improvements in non-linear distortion of grounded emitter amplifiers can be obtained by employing non-linear correcting networks. This paper describes the development of these networks for voltage and power amplifiers operating in single-ended and push-pull circuits, and class A and B conditions. Consideration is also given to grounded collector and base configurations.

It has been shown[2] that the majority of non-linear distortion occurring in a grounded-emitter transistor amplifier is primarily due to the non-ohmic characteristic of the base-emitter junction. This is generally masked to a certain extent by the ohmic internal resistance of the source employed to drive the amplifier; the ideal being achieved by a truly constant current source of infinite internal impedance. However, it cannot be assumed that the ratio of base and collector currents is constant over a large signal range and this inconsistency leads to a further, if only secondary, source of non-linear distortion.

The over-all non-linearity of a transistor can be conveniently assessed by employing a concept of transfer resistance.[3] This transfer resistance can be defined as:—

$$R_t = \frac{V_1}{I_c}$$

for any particular set of operating conditions, where V_1 is the net signal plus bias voltage applied in the base-emitter circuit and I_c is the corresponding collector current. Thus the value of R_t will include the effects of any linear resistance included in the base-emitter circuit and will also depend, to a certain extent, on the values of the collector supply voltage and the collector load impedance.

It is evident that the concept of transfer resistance as applied to a transistor allows its operation to be assessed in terms of input voltage rather than input current. For large signal applications this has been shown[4] to be more convenient than the conventional method of considering the transistor as a current amplifier.

It has previously been shown[5] that the inherent non-linearities of vacuum tube amplifiers may be reduced by the addition of complimentary non-linear networks. The degree of improvement obtained and the range of amplitudes over which this improvement is possible is by no means unlimited.[6,7] However, improvements of the order of 20 db are possible over original harmonic contents ranging from one to five per cent.

The object of this paper is to show how non-linear elements may be added to the input circuit of a transistor amplifier to provide a substantially constant value of R_t over the large-signal range of operation. The reduction of harmonic content so obtained can be judged by comparison with the improvement achieved by the use of negative feedback for the same reduction in gain. This allows a figure of merit to be established as defined by:—

Figure of Merit = (Reduction in distortion due to compensation) − (Reduction in gain due to compensation).

The methods discussed here include examples of the application of compensating networks to single-ended and push-pull amplifiers operating under Class A and Class B conditions. No detailed consideration has been given to the effect of these compensating networks on the frequency response of the resultant amplifier although, in common with similar results obtained for vacuum tube amplifiers, no significant changes are observable within the audio frequency band.

Transfer characteristics

Assuming that the load impedance of a transistor stage is linear, then the over-all linearity of the complete stage can be assessed in terms of the relationship between input voltage and output current. Fig. 1 shows a typical set of such characteristics for a 2N107 transistor connected in the common-emitter condition and operating into a resistive load. These curves illustrate the relationship between the input voltage, V_1, and the collector current, I_c, for three different values of source resistance, R_g. Curvature in the region of low values of I_c is due to the non-linear character of the base-emitter resistance and is most evident for smaller values of R_g. Curvature in the opposite direction, for higher values of I_c, is primarily due to changes in the ratio of collector and base currents and is most noticeable for higher values of R_g.

Ideal transfer characteristics are exemplified by either of the lines OQ, PQ, drawn with respect to the

*President, Nova Scotia Technical College, Halifax.
†Research assistant, Ohio State University, Columbus, Ohio.

At the time this paper was prepared both authors were affiliated with Royal Military College of Canada, Kingston. The work described in the paper was supported by Defence Research Board through a Grant-n-Aid to Royal Military College.

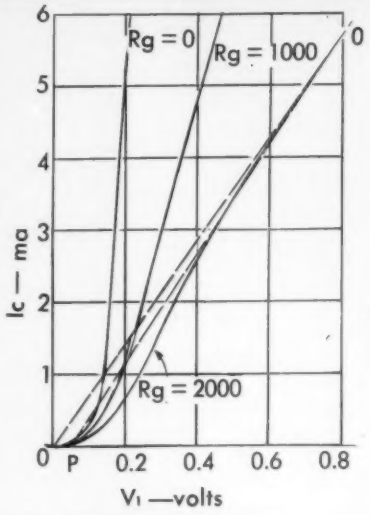
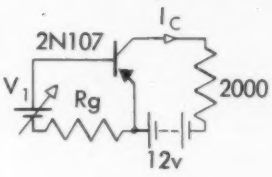


Fig. 1. Transfer characteristics.



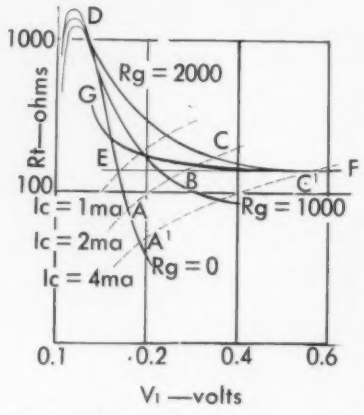


Fig. 2. Effect of Rg.

curve representing $R_g = 2000$ ohms. The line OQ, running through the origin is a transfer characteristic representing a constant value of R_t, in this case a value of 140 ohms. The line PQ necessarily represents a variable value of R_t which must, by definition, approach infinity at zero collector current. The value of R_t, for any given value of V_1, can be calculated in terms of the slope of the ideal transfer characteristic:—

$$S = \frac{\Delta I_c}{\Delta V_1}$$

and the horizontal intercept of this characteristic for a zero value of collector current. In this case it is given by the distance OP.

$$\text{Thus, } R_t = \frac{V_1}{S(V_1 - OP)}$$

It is evident that both of these ideal characteristics will intersect the realizable characteristics of successively smaller value of R_g from $R_g = 2000$ down to $R_g = 0$. If, therefore, R_g can be made variable, and corresponding to the values required for intersection at each value of V_1, then an over-all linear characteristic will result.

Effect of R_g on transfer resistance

A commonly used method of improving the non-linear characteristics of the base-emitter junction is to drive the transistor from a source with an artificially increased internal impedance. This has the effect of making the input source approach the ideal of a truly constant current generator. Under these conditions, the over-all transfer resistance of the amplifier can be written as:—

$$R_t = \frac{V_1}{I_e} = \frac{V_{be} + I_b R_g}{I_e}$$

where R_g is the sum of the internal resistance of the source of V_1, plus any linear resistance added in series.

Since the ratio of $\frac{I_c}{I_b}$ is reasonably constant over the majority of the working range, it is evident that an addition of R_g ohms in the base-emitter circuit will result in the addition of:—

$$\frac{R_g I_b}{I_e} \text{ ohms}$$

to the value of the transfer resistance. This is illustrated in Fig. 2 which shows plots of R_t against input voltage for various values of R_g, for the same transistor depicted in Fig. 1. The effect of adding a linear resistor R_g to the base-emitter junction is illustrated along the line of constant collector current ABC. In this region the vertical intercepts of resistance between AB and BC are each equal to approximately 50 ohms corresponding, in each case, to the added value of R_g divided by the corresponding ratio of $\frac{I_c}{I_b} = 20$. It will be noticed, in the region of D that the transfer resistance for the case of $R_g = 0$ is greater than that for higher values of R_g. This is due to the reversal of I_b in this region resulting in the expression:—

$$R_t = \left(\frac{V_{be}}{I_e} - R_g \frac{I_b}{I_e}\right)$$

for this particular condition.

The line EF illustrates a transfer characteristic corresponding to a constant transfer resistance of 140 ohms, as exemplified in the line OQ of Fig. 1. It will be noted that at a collector current of 1 ma a value of $R_g = 0$ would be required to obtain this condition. For a collector current of 2 ma, the required value of R_g is determined by the vertical intercept between A and B (62 ohms), multiplied by the ratio of $\frac{I_c}{I_b} = 20$, giving a new value of $R_g = 1240$ ohms. Similarly at a

collector current of 4 ma the vertical intercept between A and C is 94 ohms indicating a required value of $R_g = 94 \times 20 = 1800$ ohms to maintain the original value of $R_t = 140$ ohms.

In the same way, the curve GF represents the R_t relationship for the idealized characteristic PQ shown in Fig. 1. The required R_g characteristic, to realize this ideal, can be obtained, as before, by taking vertical intercepts along lines of constant collector current and multiplying by the factor I_c/I_b.

A more convenient method of determining the required R_g characteristic is indicated in Fig. 3. In this case, the circuit was established for a value of $R_l = 2000$ ohms and the required R_g characteristic determined for a constant value of $R_t = 140$ ohms. For any value of V_1, R_g is adjusted until $V_2 = V_1$, indicating the necessary condition for $R_t = 140$ ohms. The corresponding voltage drop across R_g is then measured (V_g) resulting in the required characteristic shown at curve AB.

This resistance characteristic bears a marked similarity to that obtained by a suitably biassed and shunted PN junction. This is illustrated in the curve AC which represents the resistance-voltage characteristic of a 1N34 diode biassed as indicated in the illustration. By including such a network in the input circuit of an amplifier, a reduction in non-linear distortion, with only a slight reduction in gain, can be anticipated. The degree of improvement obtained will depend upon the accuracy with which the desired R_g characteristic can be simulated by a varistor network. However, the natural resistance-voltage characteristic of any given varistor can be modified by adding trimming (shunting) and padding (series) resistors and by adjusting the external bias voltage[8].

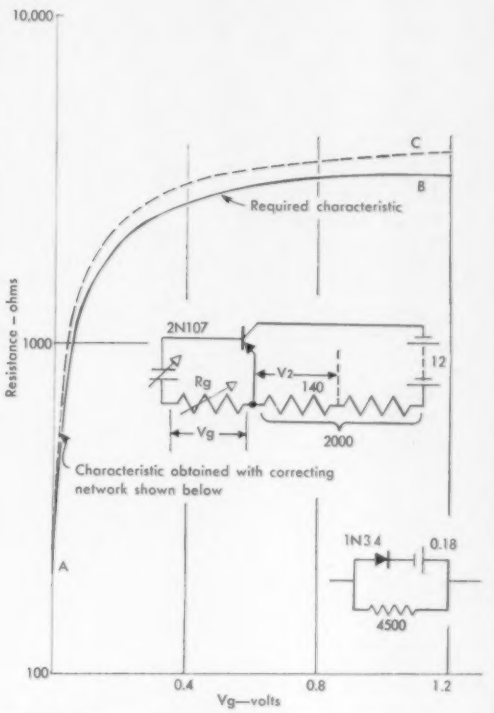


Fig. 3. Compensating characteristic.

Correction of non-linearity

A practical circuit involving a correcting network similar to that described above is shown in Fig. 4. In this circuit, bias for the compensating network, comprising the 1N34 diode and its associated shunting resistors is obtained by potentiometer effect from the temperature stabilizing resistor in the emitter lead. The compensating network was adjusted, in this case, to give minimum distortion at an output of 2.5 volts (RMS). The comparative figures of total harmonic content are shown referred to an uncompensated case in which the whole of the compensating network is replaced by a 2500 ohm resistor. The reduction in distortion achieved at an output of 2.5 volts is 11 db, while an increase in gain of 1 db results from the addition of the compensating network. This results in a figure of merit of 12 db.

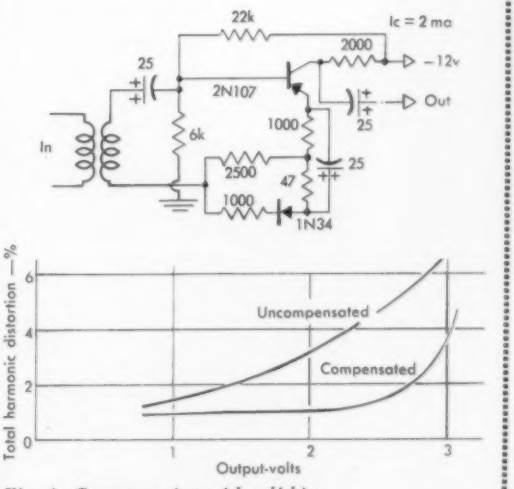


Fig. 4. Compensation with self bias.

Power amplifier

In most power amplifiers, the majority of non-linear distortion usually occurs in the ultimate or maximum power stage. Curve AB in Fig. 5A represents a typical transfer resistance characteristic for a 2N188A transistor measured under conditions simulating transformer coupled operation, at the recommended collector current of 11 ma and an operating V_{cc} of 9 volts. These results were obtained using a resistive load of 500 ohms, corresponding to the primary

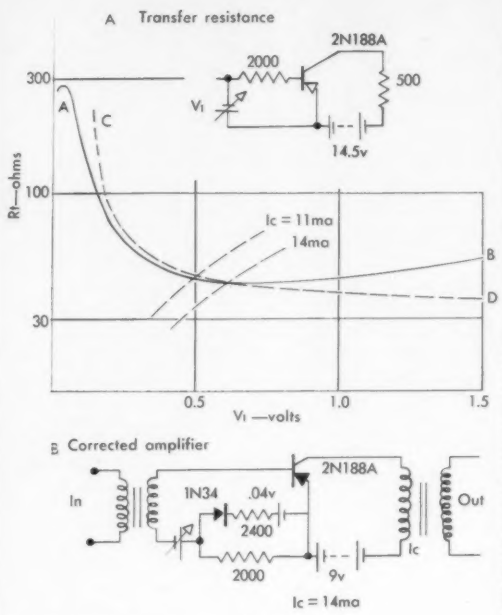


Fig. 5. Transformer coupled load.

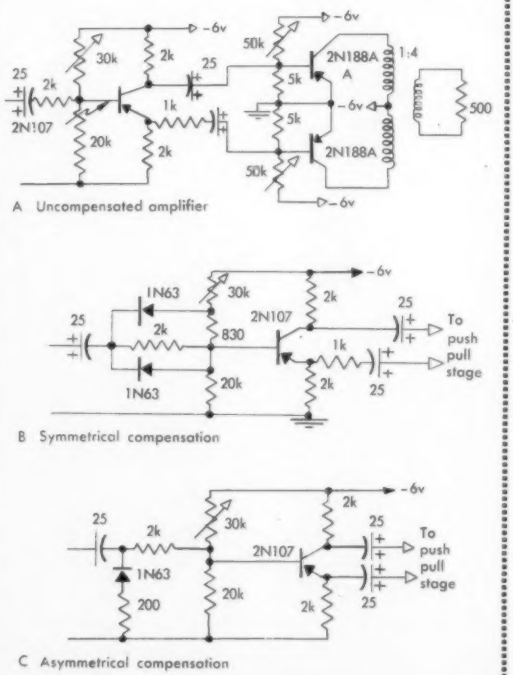


Fig. 6. Class A push-pull amplifier.

impedance of the output transformer, and an increased value of $V_{cc} = 14.5$ volts to compensate for the 5.5 volt drop in this resistor under quiescent conditions. It will be noted that for higher values of collector current, the transfer resistance begins to rise with increasing input voltage due to the low net value of collector voltage under these conditions.

The curve CD represents the transfer resistance of an idealized transfer characteristic based on the slope of the collector current-input voltage characteristic at the quiescent point. It is evident from the deviation of these two curves that the bulk of distortion will occur at high peak values of collector current due to the approach to bottoming mentioned above. In addition, it will be noted that the recommended value of quiescent collector current will give optimum operating conditions. Correction for the bottoming effect can be achieved by employing a compensating network of the form shown in Fig. 5B. Such a network, by reversal of the diode, is designed to have no effect on the circuit for negative excusions of the collector current. For positive excursions, however, it tends to reduce the source resistance and thus reduce the transfer resistance to match the idealized characteristic more closely. With this result achieved, it is now possible to increase the quiescent value of I_c so that for the same output voltage less distortion occurs on negative excursions of collector current. These results are shown in Table 1.

TABLE 1

All figures for 4 volts (RMS) Output

Case	I_c ma	Compensation	Gain db	Total harmonics %	Figure of Merit
A	11.0	Uncompensated	22	3.2	12.7
B	11.0	Compensated	22.5	0.8	12.7
C	14.0	Uncompensated	22.1	4.8	17.7
D	14.0	Compensated	23.0	0.7	17.7

It will be noted that a slight increase in gain is obtained by the application of compensation in both cases B and D. This is due to the slight lowering of the transfer resistance over the majority of the range of output signal, and from the general improvement in the form factor of the output signal. Although individual bias sources have been shown in this figure for both the base-emitter junction and the compensating network, it is evident that a single d.c. power source may be used as illustrated in the previous example.

Push-pull operation

Correction for push-pull operation can be achieved by inserting either a symmetrical or asymmetrical compensating network before phase inversion takes place or by employing two individual asymmetrical compensating networks after the phase inverting stage. Fig. 6A illustrates a typical phase inverter and push-pull stages without compensation. It will be noted that a 1000 ohm resistor is employed in the coupling network at the output of the emitter of the

phase inverter in order to obtain a balanced output. Fig. 6B shows a symmetrical compensating network employed in the input of the phase inverter stage, with correcting network bias obtained from the phase inverter bias resistors. Fig. 6C depicts an asymmetrical compensating network again inserted immediately in front of the phase inverter. In this case, however, the 1000 ohm balancing resistor has been eliminated; its role being assumed by the compensating network. Table 2 illustrates the results obtained with these arrangements, where, in all cases, the adjustable bias resistors have been set to give a collector current of 2 ma, in the 2N107 transistor, and 30 ma in each 2N188A transistor.

TABLE 2
All figures for 3 volts (RMS) Output

Case	Compensation	Total harmonics %	Gain db	Figure of merit db
B	Symmetrical	0.47	20	9.5
A	Uncompensated	1.32	19.5	9.5
C	Asymmetrical	0.42	21.3	11.8

Compensation after phase inversion is exemplified by the Class B amplifier illustrated in Fig. 7. Harmonic distortion for the compensated and uncompensated case is shown; the quiescent collector current for each transistor being set at 1 ma. At an output level of ten volts, an increase in gain for the compensated case of 1.2 db was observed with a corresponding decrease of 13.8 db in distortion. This gives a figure of merit of 15 db for this condition. It will be noted that the compensating networks are not identical in form. Thus W_1 required a forward bias but no series resistor, while W_2 required no bias and a series resistor to achieve balance. The varistors used in this case were multiple copper oxide (Westinghouse 40B) and these differences are due partially to the deviation of characteristics between varistors and partially to the lack of symmetry between transistors.

Inter-stage compensation

Fig. 8 illustrates the effect of employing a non-linear inter-stage coupling network to compensate a single-ended power amplifier. In this particular case, no bias for the compensating network was required although this could, if necessary, be obtained from the bias resistor of the power stage. The relative harmonic distortion for the compensated and uncompensated cases is shown in the figure. In each case, the individual transistor bias controls were set to give a collector current of 2 ma in the 2N107 and 14 ma in the 2N188A transistor. At an output level of four volts, the compensated amplifier has an increase in gain of 1.4 db, with an improvement of 13.9 db in distortion over the uncompensated case, giving a figure of merit of 15.3 db.

Common collector configuration

The common collector configuration provides transfer characteristics which are similar in general shape to those of the common emitter amplifier. The degree

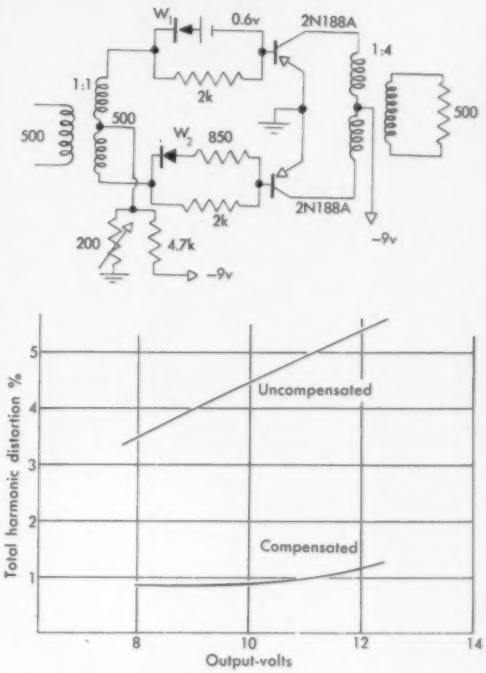


Fig. 7. Class B push-pull amplifier.

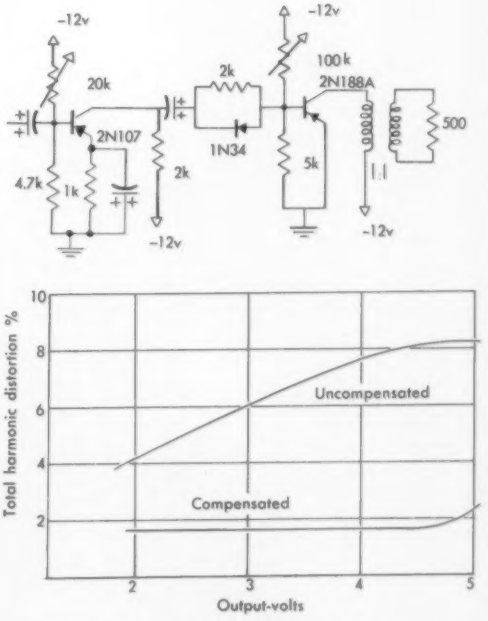
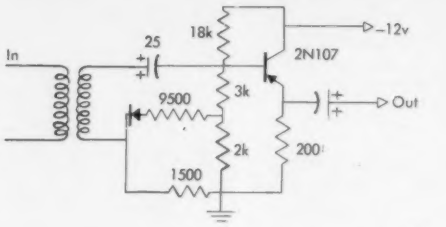


Fig. 8. Two-stage single-ended amplifier.



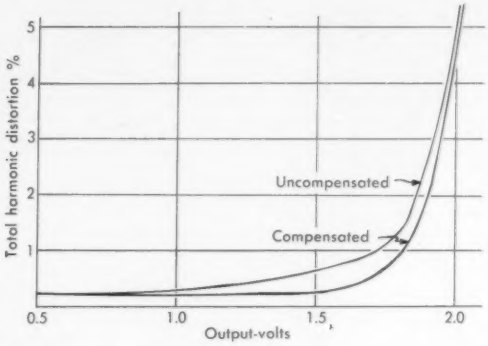
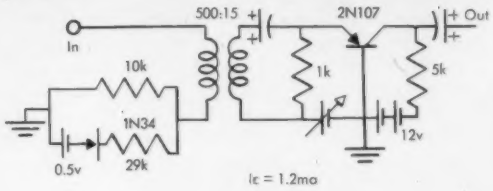


Fig. 9. Common collector amplifier.



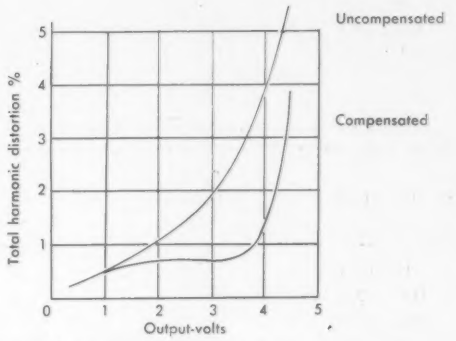


Fig. 10. Common base amplifier.

of deviation from the ideal is, however, markedly smaller than in the case of the common emitter connection. Similar methods of compensation again apply and Fig. 9 exemplifies such a condition. In this case, bias for the compensating network has been derived from the base bias resistor chain and is for this particular example 1.0 volts for a collector current of 5 ma. The comparison of total harmonic distortion for the compensated and uncompensated cases is shown in the figure and indicates an improvement of 9.3 db at an output level of 1.5 volts. An increase of gain of 2 db is realized in the case of the compensated amplifier, yielding a figure of merit of 11.3 db. An alternative method of obtaining bias for the compensating network can be used. This consists of tapping off the required bias voltage from the emitter resistance with an appropriate re-arrangement of the base bias resistor chain.

Common base connection

Although the transfer characteristics of the common base configuration are similar in form to those of both the other configurations, correction in this case is achieved by very small changes in the value of R_g This is due to the comparatively very low input impedance of such an amplifier. Because of this factor, compensation in the input circuit of a common base amplifier must be achieved at a higher impedance level than the base itself. A demonstration circuit of this is shown in Fig. 10 in which the compensation network is included in the primary circuit of the input transformer. This transformer has a 500:15 impedance ratio so that changes in the resistance of the compensating network are effectively stepped down in that ratio.

As shown in the comparative results for the compensated and uncompensated case, an improvement of 11.2 db is achieved in harmonic content at an output voltage of 3.5 volts. An increase in gain of 0.3 db for the same condition yields an over-all figure of merit of 11.5 db. While Fig. 10 does not illustrate a practical method of applying compensation, it does, however, demonstrate that this method could conceivably be applied in a previous stage of amplification.

Discussion

At the outset, it should be emphasized that all comparative figures of distortion and gain quoted above have been based upon the following conditions:—

(a) Compensated:—With the compensating network as shown in operation.

(b) Uncompensated:—With the fixed shunting resistor of the compensating network alone in circuit, all other connections in the compensating network being broken.

In all cases, the operating condition of collector current was maintained during the comparative tests.

Tests have also been made of intermodulation distortion both for compensated and uncompensated conditions. In all cases, improvements were achieved of the same order as those obtained for harmonic distortion. No significant change in frequency response is brought about by the addition of the compensating circuits, although frequency responses within the 20–20,000 cps range, only, were examined. Deterioration of the frequency response is not likely

to be serious because, in all cases, the capacitance of the semi-conductor in the compensating circuit is shunted by a comparatively low value of resistance.

Conclusions

The foregoing paragraphs indicate that substantial improvement in non-linear distortion can be achieved in transistor amplifiers by employing non-linear networks prior to the final stage of amplification. In general, these results can be achieved by making a preliminary estimate of the non-linearity inherent in the amplifier in terms of the transfer resistance characteristic. A practical approach to the design of the required non-linear network is to measure the value of R_g required to match the predicted idealized transfer resistance for each value of instantaneous signal voltage. An approximation to the required R_g characteristic can then be obtained in terms of a suitably biased varistor with associated shunt and series resistors. Final adjustments of the bias and resistor values can then be made under operating conditions to achieve minimum distortion. The resulting network can then be modified to eliminate the separate bias source by using an already existing bias voltage in the original amplifier.

No examination of the effects of temperature on a compensated amplifier has yet been made. In most instances, the non-linear element employed in the compensating network will be temperature sensitive and, depending upon the configuration, may aggravate or alleviate the effects of temperature on the original transistor. These results have been obtained using readily available semi-conductors as non-linear elements in the compensating networks. It is evident that such elements provide only a compromise to the required ideal compensating characteristic. It is likely that more complex non-linear elements, composed of dissimilar types of semi-conductor, might provide closer approximations to the ideal compensating networks required for even greater reductions in distortion.

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EIA export committee—continued

est in the export field and of these, one or two have already become active in the field since the committee was set up.

"The most obvious purpose of the Export Committee is to help each other with mutual problems such as export licenses, long and short term credit information, and a knowledge of tariffs inasmuch as they affect electronic goods.

"Primarily, this means that we are trying to help each other solve the mechanical problems of the export business. We cannot tell the other fellow how to run his business, nor would it be good business to attempt to set up combines.

"One thing we can do, however, is help companies obtain information on market, regulations and local conditions in the countries they are contemplating. This is done mainly through the Department of Trade and Commerce, who have set up foreign trade offices (mostly in embassies) in many cities throughout the world. Sometimes they can supply information on tenders being called.

"But despite any help from either the Export Committee or the government, it is still essential that a company have its own agents in the country where it expects to do business. The job of selling the customer is one for the company and not for us or the government.

"In order to keep development going and to remain healthy, it is necessary for the company to expand. But to sell in the world market you must be competitive. And it is a tribute to the Canadian electronics industry generally that, particularly in the field of communications, we can produce equipment at competitive prices."

Second place-manship

In a recent speech, Dr. Arnold O. Beckman, president of Beckman Instruments, Inc., warned of a "second place-manship" philosophy that endangers the foundation of the American electronics industry — its technical creativity.

"This philosophy is translated into a business strategy which leaves the pioneering leadership to others with the aim of grabbing business through the quick production of a cheaper version of the pioneer's product. I think this is an exceedingly dangerous note in an industry which has based so much of its success on basic innovation."

Dr. Beckman made his call for a "rededication to technical leadership" before some 400 electronics executives attending the 1961 Western Electronic Show and Convention, San Francisco.

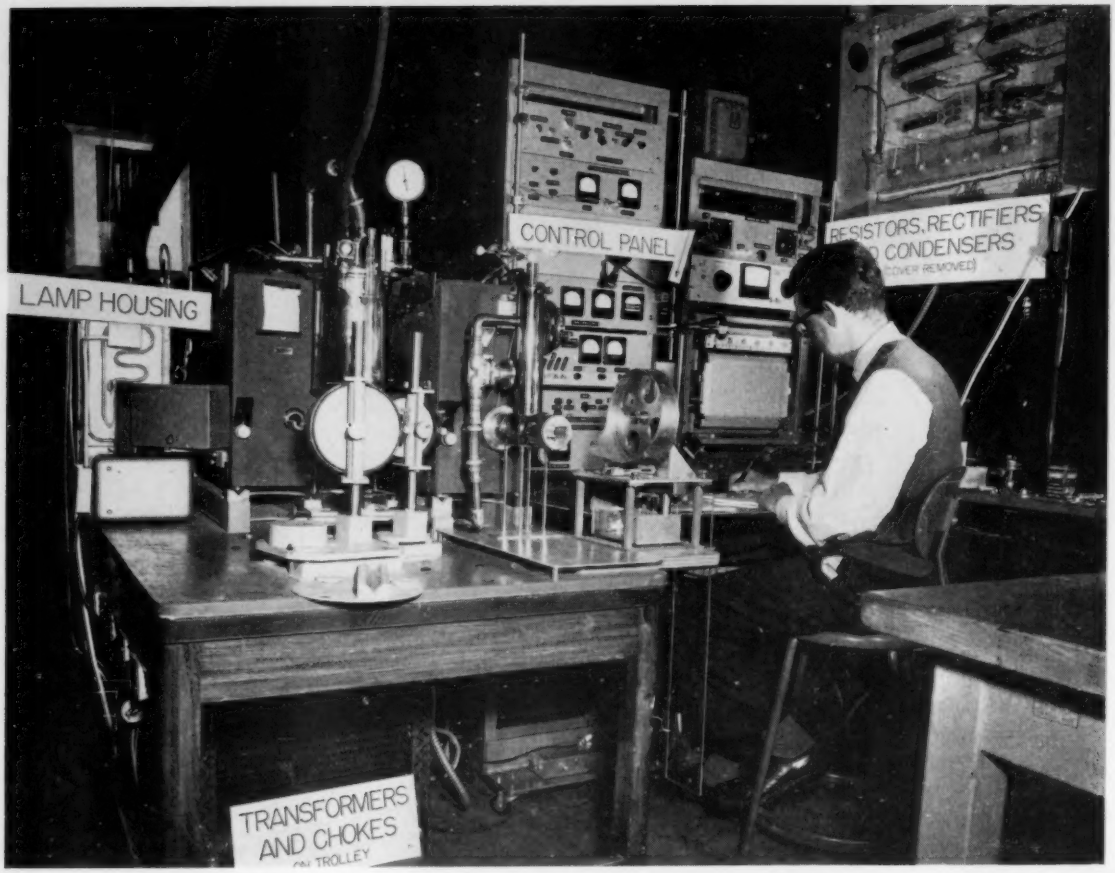

Fig. 1. Arrangement of components of prototype power supply. Heavy items are mounted on trolley, resistors on wall.

Efficient three-phase supply powers Xenon arc discharge lamps

M. P. MacMARTIN & F. R. LIPSETT, PhD*

Xenon arc discharge lamps require special power supplies: the voltage needed to start a lamp is about three times the operating voltage, and the lamps have small negative resistance. The supply described here takes power from a 575-volt, 60-cps, three-phase line, then rectifies and filters it.

In recent years Xenon arc discharge lamps of extremely high light intensity have become available. These lamps are useful for the projection of colored motion pictures because the visible portion of their light closely approximates natural sunlight, and because they eliminate the need for carbon electrode feeds, with their attendant mechanical difficulties. They are useful for research purposes because of their intense continuous ultra-violet light.

The electrical characteristics of the lamps are similar to those of other arc discharge lamps. The lamp for which the supply was made requires at least 65 volts to start, but not more than 110 volts, and has about 27 volts across it when operating. The lamp is normally operated at a current of 75 amperes dc though it may be operated down to 45 amperes. At full current, the lamp power is 2,000 watts. An ignition device, supplied by the lamp manufacturer, is necessary for starting. This applies to the lamp a 40 kilovolt pulse, generated by a spark gap and a transformer, which initiates the discharge. The lamp subsequently operates from the power supply.

There were several possible methods of designing a power supply, using power from various sources, as follows:

1. Operation from a 110 vdc line. This would have

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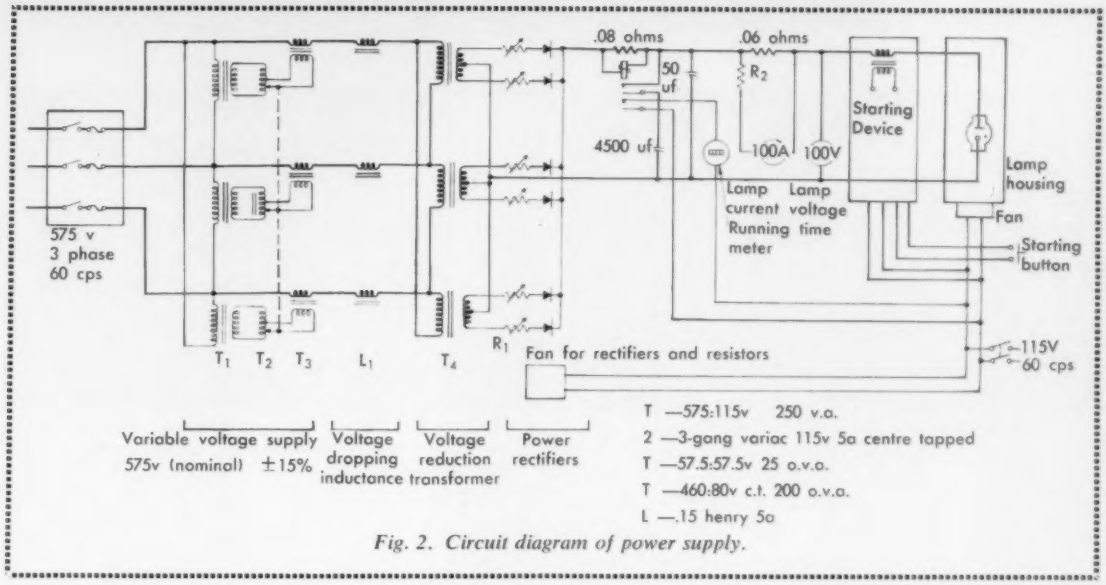


Fig. 2. Circuit diagram of power supply.

necessitated a ballast resistor dissipating 6,300 watts, which was unacceptable.

2. Operation from a motor-generator set with a controlled field on the generator. This possibility was investigated in some detail, as a 500 w Xenon lamp was formerly operated satisfactorily in this manner, using a set which happened to be on hand. A new set, of the required power, proved to be prohibitively expensive, however, and this method was rejected.

3. Rectification from a 115 v, 60 cps, single-phase line. This would have required very heavy filtering to provide a sufficiently low ripple voltage for the lamp, which would have been expensive and wasteful.

4. Rectification from a 575 v, 60 cps, 3-phase line. This method had none of the disadvantages of the foregoing, and was adopted. The circuit for the supply is described below.

Description of circuit

A circuit diagram of the power supply is given in Fig. 2. The principle of operation is as follows. Power from the line is fed to three transformers, *T1*, which supply the buck-boost circuit, and thence through the secondaries of three buck-boost transformers, *T3*, to three chokes, *L1*, and three voltage-reducing power transformers, *T4*. After rectification and additional RC filtering the dc power passes to the lamp through the starting device. A relay switches in the filtering condensers and operates a running time meter after the lamp has started.

The buck-boost circuit is necessary for two reasons. The first is to allow some variation in the lamp intensity; but in the present application, in which the lamp is normally operated at full current, this is not of great importance. The main need is because the line voltage may vary from about 560 to 610 volts throughout the course of a day, and it is desired to operate the lamp at a fixed current. The adjustment is made by a three-gang Variac, assembled from 3 standard 5A Variacs to which centre-taps were added, and buck-boost transformers.

It would be easy to drive the Variacs by a small motor, geared to the handle. The motor could be controlled by a phototube which would measure the light from the lamp, or alternatively by a measure of the current to the lamp. In this way the lamp light or lamp current could be kept constant, and line voltage variations would not affect the output. However, in the present application this refinement is not necessary. The variation in voltage possible is ± 15%, and the maximum open-circuit voltage on the lamp is 86 v, which is well within the allowable maximum.

The chokes, *L1*, provide the main impedance of the supply, and serve to drop the voltage on the lamp to its operating value after starting. They carry ac current only. The voltage-dropping power transformers carry the full power to the lamp. These transformers and the chokes were specially wound for the power supply. All other components are standard items.

The impedance preceding each rectifier, which includes a resistor, the impedance of transformer *T4*, and the voltage dropping inductance, ensures that the current through each rectifier is not a series of sharp pulses, passing through only one rectifier at a time. The load current is transferred gradually from one rectifier to the next in sequence, over about 60 electrical degrees, and two rectifiers are conducting at every instant of time. The waveform of the current through each rectifier is shown in Fig. 3. The resistors R in series with each rectifier are padded so they can be adjusted from .033 to .042 ohms. They are used to balance the six phases, with the aid of an oscilloscope, so that the voltage at the lamp is as uniform as possible. Very little adjustment was found necessary.

It is important that the transformers *T4* be connected in delta as shown in Fig. 2, rather than wye, so that the large third harmonic component of the current in the transformers does not flow in the chokes. This is shown in Fig. 4. The harmonic content of the choke current, assuming that the transformer currents are exactly triangular in shape, contains zero third harmonic, 4% fifth harmonic, and 2% seventh harmonic, as can be shown by a Fourier analysis of the waveform.

The silicon rectifiers are rated at 25 a nominal, 300 v peak inverse, and are operated at 12.5 a each. These

Xenon lamp power supply

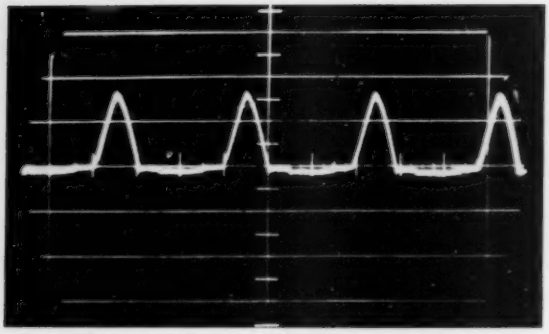


Fig. 3. Waveform of the current through a rectifier.

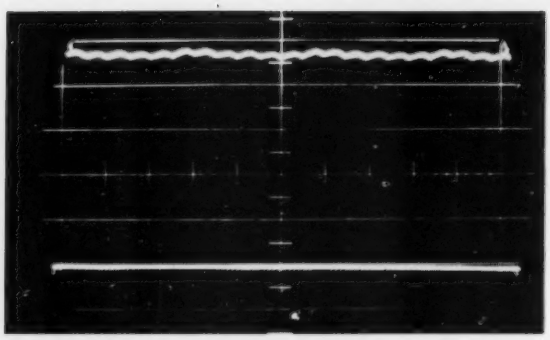


Fig. 5. Waveform of the voltage applied to the lamp.

rectifiers are especially useful in the present design because of their high current capacity, absence of heater transformers, small size and long life, in comparison with vacuum tube rectifiers. The silicon rectifiers are mounted on a 4-in. aluminum channel, 18-in. long, which acts as a heat sink. The channel reaches a temperature of 45 C in operation, which is well below the maximum allowable temperature of 130 C.

The high-current resistors in the dc line and the 4,500 uf condensers reduce the ripple across the lamp and also limit the lamp current. The 50 uf condenser was found necessary to start the lamp. Apparently the energy stored in this condenser is necessary to initiate the discharge. The ammeter was checked against an accurate ammeter placed in series with the lamp, and the resistor *R2* was selected to make the readings correspond.

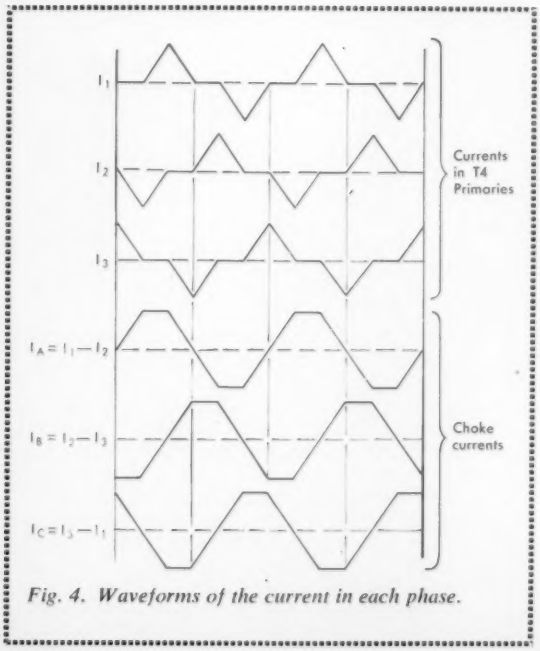


Fig. 4. Waveforms of the current in each phase.

Fig. 1. shows the arrangement of the components. All the heavy components, which weigh approximately 300 lb., are mounted on a trolley. The resistors, which produce heat, are mounted on the wall of the room and are cooled by a blower. The controls are mounted on a relay rack together with controls for the optical apparatus. The lamp is mounted directly adjacent to the starting device, in order to keep the leads short. It is ventilated by a blower in order to remove ozone, which the lamp produces at a substantial rate and which, of course, is toxic. The exhaust air is passed to the exhaust of a fume cabinet in an adjacent laboratory and thence out of the building. The lamp housing is water-cooled to prevent over-heating of the adjacent optical apparatus.

In order to operate the lamp the 575 v and 115 v lines are switched on, and the starting button is pushed. When the lamp has started, the current may be adjusted by means of the Variacs. To extinguish the lamp the 575 v line is switched off.

The Xenon lamp used with this power supply is an Osram XBO 2001 which has a pressure of 8 atmospheres at room temperature, and 25 atmospheres at operating temperature. There is a possibility of explosion, therefore, and the lamp should be handled only while wearing gloves and goggles, and it must be enclosed in a sheet metal housing. Because of its high intensity, the lamp should not be viewed with the naked eye.

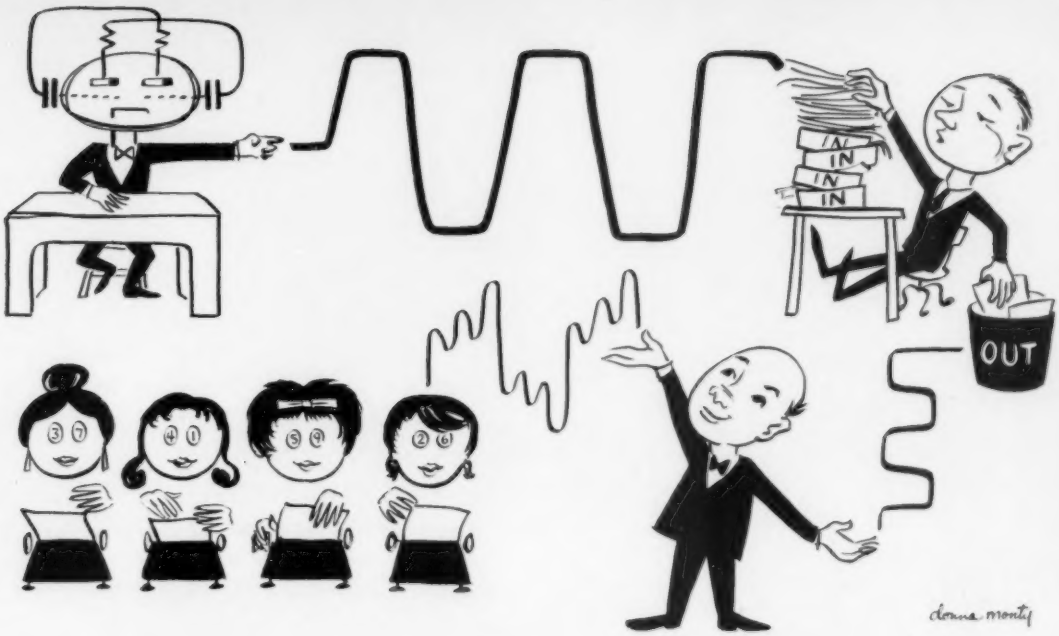
In the present application the 1600 w lamp is incorporated in an optical apparatus for investigations of the fluorescence of crystals[1]. The supply has operated satisfactorily since being put into operation. The ripple voltage at the lamp is approximately 1½% rms, which is well within the recommended maximum value for the lamp, and is quite acceptable for the experiments for which it is used. The lamp voltage, showing the amount of ripple, is illustrated in Fig. 5. The intensity of the lamp was found to be even higher than anticipated, in comparison with the lamp originally used, and has made possible a substantial increase in the resolution of the optical apparatus.

Acknowledgements

We are grateful to Messrs. N. L. Kusters and J. H. Simpson for helpful discussions, and to Mr. B. Kettles, who assembled the power supply. END

REFERENCE

1. F. R. Lipsett, J.Opt.Soc.Am. 49, 673 (1959).



Electronic circuits explain the Webber principle of scientific management

A. P. HARRIS, P.ENG. Ottawa.

People exhibit characteristics analogous to electronic circuit functions and after correct classification they can be placed in series or parallel circuit arrangements to produce impressive, if not useful, output. This is a "less than serious" discussion of the Webber principle.

When an electronics engineer performs some scientific feat for his company he is permitted to write a technical paper on his achievement at his own time and expense.

If he performs a series of scientific or engineering feats which cannot be ignored by the management, he is immediately relieved of all technical responsibility and made an administrator. It is explained that while the rate of pay remains the same his avenues for promotion and the acquisition of peptic ulcers are increased considerably.

Instead of inoperative equipment he must now deal with malfunctioning people. His time will, in part, be spent in assessing the optimum duration of coffee breaks, the useful output of his group in terms of mean effective unit hours per project month and in compiling forms and procedures which prevent people from performing essential functions. It will rapidly become apparent to him that his principal task is to get to work in harmony (or at all), a group of people whose education, qualifications, and personalities are absolutely incompatible. With no previous training or experience in this field, excluding his marriage, he is likely to become disheartened and to consider leaving the electronics field for some less serious undertaking such as the exploration of space.

For those who are discouraged we offer Webber's Principle, now revealed for the first time with permission of its creator, which permits full utilization of previous electronics training.

The Webber Principle was developed by J. W. Webber during his tenure with the Defence Production Board where he was employed at the time for other purposes. It says, in short, that people exhibit characteristics analogous to electronic circuit functions and that after correct classification they can be placed in series or parallel circuit arrangements to produce impressive, if not useful, output.

Suitable hook-ups can be arranged to produce the desired result of administrative amplification, filtering, control, etc. If there is any difficulty with this process it is in the correct classification of the staff in the first instance. The method of classification is best explained by example.

The amplifier whose gain is less than unity

This man is all too common an element in business or engineering offices. Inability, disinterest or downright incompetence have lowered his output below the unity level so that he produces less work than the effort required to get him to produce such work. He may be readily identified by mounds of paper on his desk or by the presence of supplementary "in" baskets on separate tables.

The unstable oscillator

A powerful generator of transient activities and ideas all unrelated to the job he has been given.

When heavily suppressed, only a low amplitude carrier remains or he tends to stop oscillating completely. His presence can be detected by scanning bands remote from

(Continued on page 47)

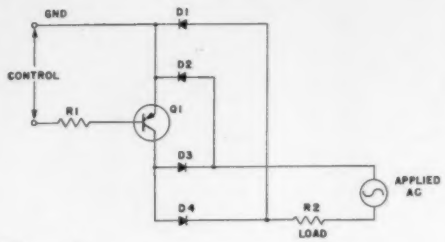


Figure 1.

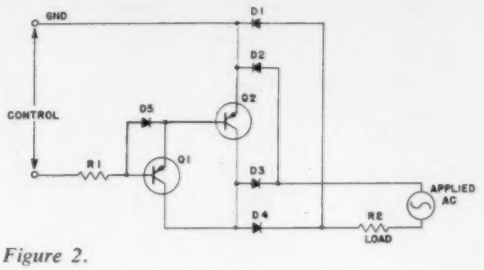


Figure 2.

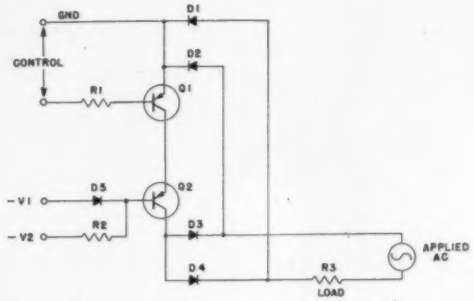


Figure 4.

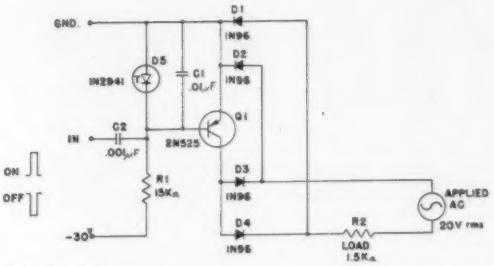


Figure 5.

Switching ac with transistors

J. LENG*

The basic a-c transistor switch utilizing one transistor requires a control current proportional to the load current. This article describes three circuits for applications with low control current, pulsed control signals, and high voltage.

A basic ac switch uses one transistor and four diodes as shown in Fig. 1. Either the dc control or the applied ac is a floating supply. The diodes route both halves of the ac current in the same direction through the transistor. If the base is held positive with respect to the emitter, the transistor is cut off and only leakage current flows. But if the voltage on *R1* is made negative with respect to the emitter, base current flows and the transistor allows both halves of the applied wave-form to appear across the load *R2*. The value of *R1* must be such that the control current through it, multiplied by the minimum gain of the transistor, either equals or is greater than the peak current passed by the load. To reduce this control current a second transistor can be added as shown in Fig. 2 and some of the waveforms produced with this circuit are shown in Fig. 3. Thus, the power dissipated in the load may be controlled by varying the width of the input pulse. If the load is inductive, then by switching on or off when the current waveform is passing through zero, problems due to inductive surges do not exist. It is also noticeable that these waveforms resemble those associated with some magnetic-amplifier circuits and further applications suggest themselves here.

Where voltages higher than the breakdown voltage of the transistor are to be switched, the circuit in Fig. 4 can be used. Transistor *Q1* is held off by maintaining the voltage on *R1* above ground and with —*V2* lower than —*V1* the base of *Q2* is held at —*V1* potential. Voltage *V1* must not exceed the breakdown voltage of the transistors and *V2* is any convenient voltage below *V1*. With *Q1* held off the ac applied voltage can have a peak value of *2V1* without appearing across the load. When the voltage on *R1* is taken below ground then *Q1* can turn on. In doing so the collector of *Q1* comes up to ground potential and cuts off diode *D5*. Transistor *Q2* now turns on, as base current flows via *R2*, and the applied ac waveform appears across the load. The value of *R2* must be such that the current through it is the same as for *R1*.

In many applications, control signals will be in the form of pulses and it then becomes necessary to make the switch bistable. The configuration in Fig. 5 shows the basic ac switch with a tunnel diode added to give the circuit two stable states. The transistor will be either on or off depending on whether the tunnel diode is in its high- or low-voltage state respectively. The capacitor *C1* across the tunnel diode prevents sporadic switching due to high-frequency pickup. The tunnel diode will switch from the low- to the high-voltage state on the back edge of a positive 5-volt pulse applied to *C2*. Likewise a nega-

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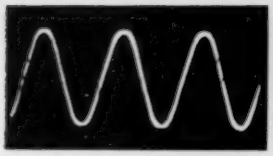

Fig. 3a. Applied waveform.

Fig. 3b. Control waveform; up is "off"—down is "on".

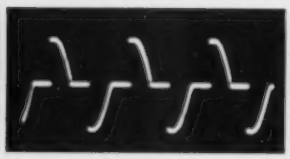

Fig. 3c. Waveform across load with control applied.

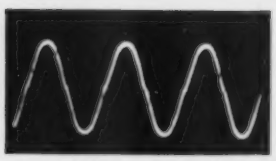

Fig. 3d. Waveform across load with switch on.

tive 5-volt pulse will switch it back to the low-voltage state. The value of *R1* in this case not only depends on the gain of the transistor *Q1* but also on the characteristics of the tunnel diode being used. The current through the resistance *R1* must be less than the peak current of the diode *D5* and greater than the valley current of the combined characteristic of the transistor and tunnel diode.

END

Webber principle—continued

his original frequency allocation or more simply by listening to the squeals of his colleagues as he goes charging across their administrative responsibilities.

The pure field

This man does no work of his own but has generated a powerful protective field which deflects incoming work to other directions. Any questions or problems are, smoothly, and with the speed of light, given to someone else. If the deflections are accurate and well placed this man is a potential president. If not he is a librarian.

The high pass filter

Usually an old timer. He has worked out his procedures and has every instruction memorized. He can quote every regulation issued by management as far back as your 14th predecessors including the one you issued last month and forgot.

Nothing will get by him that isn't in chapter 4(b).1.2 of "The Book". However, if there were no regulations concerning the use of the water cooler he would go thirsty from 9 to 5.

The high distortion amplifier

This man suffers from phase shift as well as frequency, intermodulation and harmonic distortion. Within the network of his brain cells there are innumerable short circuits and discharge points and there is no instruction, request or task so simple that it cannot be distorted beyond recognition in three moves.

There is no technical field in which he can be usefully employed except perhaps as officer in charge of some mythical military project established for the sole purpose of confounding the enemy.

The read-outs

For these and other purposes typists and stenos may be classified simply into low impedance or high impedance input types.

The multivibrator

This is a case where the work output is fed back into the input so that activity is self-sustaining in any environment. This is a potentially dangerous situation for although there is a large flow of energy, only a small amount of output may be available and, in fact, no external signals at all may be detectable. These symptoms can apply to a whole section or Division, and are characteristic of large operations. It has been postulated, in fact, that if certain Departments of Government were removed intact with all physical equipment to Andromeda III it would require 23.3 earth years for them to run down on self-generated administration. It has been further postulated (and this is irrelevant to our thesis) that it would take 7.1 years before they were missed and 1.2 years before the staff realized where they were.

The square wave generator

A square wave generator is an administrator who produces operating plans of tremendous complexity and infinity of implication and forces them into an administrative network designed for simple sine wave inputs. Heat losses, red radiation and deterioration of the insulation inevitably results.

System engineering

With the classifications completed, the required organization or arrangement of staff to produce work is self-evident on simple circuitry principles.

For example, the Unstable Oscillator can be made responsible to the Amplifier whose Gain is Less than Unity and the resultant signal fed into the High Pass Filter. In this way at least everyone is working under control although nothing much may be happening.

An obvious choice of supervisor for the Square Wave Generator is a Narrow-Band Filter, whom we haven't described but whose characteristics should be apparent.

Certain elementary precautions should be taken. Unstable Oscillators must be isolated from High Distortion Amplifiers. Reliable connections must be established with modern read outs before heavy loading can be initiated.

Various layouts can be tried using bread board techniques and new systems experimentally setup. By mounting office furniture on large castors, rapid changes in arrangement can be accomplished. This is preferred over the older system of using arrows on cards, or trails of paper or chalk marks on the floor to show the train of administrative processing that you require.

Each experimental arrangement should be tested and stresses applied to see where the weak points lie. For example, open the window wide on older members so that they sustain a strong draught; cut off all personal use of the telephone; or for a quick test to failure eliminate the morning coffee break.

These are only suggestions, of course, and the imaginative engineer will soon be able to work out techniques of his own.

A final word of warning. When everything is finally functioning smoothly and real progress is being made on the jobs on hand, it is inevitable that one of two things will happen:

(a) the management will change your job
(b) they will change your staff

so that you must begin again at the beginning.

This is "Murphree's Law" and is too involved to be stated simply here.

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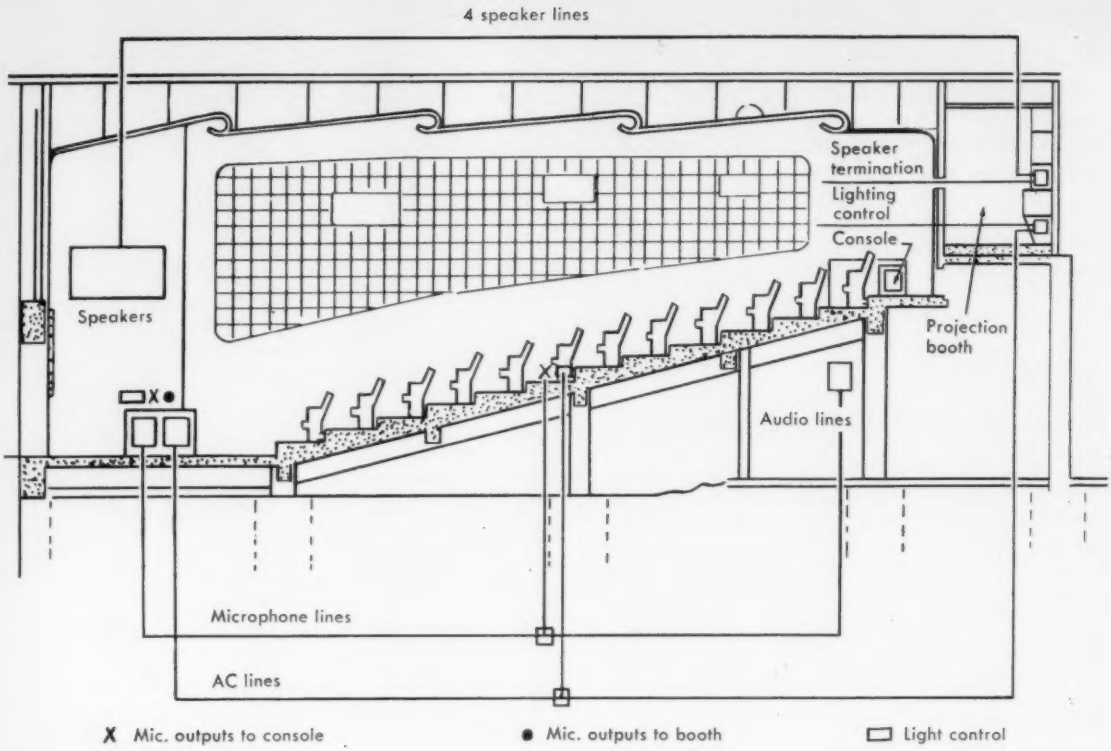

Coordinated aural and visual aids set high standard for auditoriums

N. A. C. LEWRY*

A description is given of aural and visual aids used at lectures, symposia, and conferences held in the auditorium of the Radio and Electrical Engineering Division of the National Research Council, Ottawa. Supplementary facilities for use in conjunction with the general system are outlined.

In 1953 the National Research Council expanded the facilities of the Radio and Electrical Engineering Division by providing a new building in the Montreal Road area of Ottawa. An auditorium with a 250 seat capacity was included in the building. In the design of the auditorium efforts were directed towards a high standard in:

1) speech intelligibility,
2) audience comfort,
3) illumination and sound control,
4) visual aids,
5) maximum flexibility in all phases of operation.

A primary aim in the design was the elimination, in so far as practical, of distractions to the speaker.

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Auditorium

Since the auditorium (see above) is smaller than the usual motion picture theatre auditorium, careful design is necessary to achieve the features desired. The ceiling is serrated and covered with rough plaster, the floor slopes toward the lecture table, the front wall is covered with hard plaster, the rear wall with acoustic tile backed by sound-absorbent rock wool, and the two side walls are partially covered with acoustic tile. The amount of absorption by the side walls was adjusted to give a satisfactory degree of damping. Upholstered seats having a high absorption factor are used, so that acoustic quality is not affected when a small audience is present.

Since the auditorium is too small to accommodate a stage, a lecturer's table is installed 6 feet from the front wall. A chalk board, 4 feet in height, is mounted on the front wall, and immediately above it is a 10 ft. x 11 ft. beaded screen. Sufficient space is available at the ends of the lecture table for the temporary placement of epidiascopes, reflectographs, removable projection screens, and demonstration apparatus of large dimensions. Mounted on the lecture table are: (1) microphone inputs, (2) signalling circuits, (3) power circuits, and (4) water inlet and outlet. Two triple-unit LEE Catenoid speaker systems are installed in the front corners of the auditorium near the ceiling to

give high quality sound projection. Two extra speakers are mounted in the ceiling at the rear of the auditorium for voice reinforcement purposes, and are only used with low-voiced speakers.

Sound console

A sound distribution console and associated equipment is installed at the right rear of the auditorium. The sound system consists of a two-channel amplifier with inputs for microphones, tape, film sound, and recording. Ten microphone inputs are in use at present in the following locations:

1) left and right hand sides of the lecture table,
2) centre, left and right hand sides under the front seats,
3) left and right hand aisles, halfway back,
4) at the console (two outlets) for rear area coverage,
5) wireless microphone for mobile auditorium coverage.

The inputs on the lecture and console tables can be used for voice reinforcement, with fixed or portable microphones. The two lecture table inputs and those under the front seats are useful in panel discussions, and all ten come into service for general coverage in the case of audience participation. The audio switching facilities in the console allow any of these inputs to be connected to either speaker channel, or both, for voice reinforcement.

Other available sources of audio material include playback from records, tape, or film sound track. In each case the two channels of the console can be used for binaural or stereophonic reproduction, and if the necessity arises a third channel (normally used for monitoring purposes) can be added to the output system. Normally disc recordings are of the single channel type and the signals are equalized to the correct characteristics of the record by a preamplifier. This unit is connected directly to the record input of the audio console. Tape recordings are fed to the tape input circuits of the console. Film sound track signals are fed directly from the sound head preamplifier to the film input of the console. Any signals from the console can be recorded binaurally or monaurally from the output circuit of the main amplifier. Signals from the console are amplified in the normal manner and fed to the loudspeakers or, if desired, to other areas in the building through 500-ohm lines. For maximum reliability and flexibility, switching and patching circuits are available to enable the console operator to replace any defective circuit or amplifier, or to increase the facilities by means of added external systems, at will. The addition of extra recording apparatus is frequently necessary when multi-channel recording, dubbing, and playback are required.

Projection booth

The projection booth at the rear of the auditorium is soundproof and totally isolated from the audience area. It is normally equipped with three projectors: one for 16 mm sound or silent film, another for 3¼ in. x 4 in. slides, and the third for 2 in. x 2 in. slides. Various slides of odd dimensions can be handled by means of adapters. All projectors are blower-equipped for continuous operation. Accurate focusing of all projectors is accomplished by means of 7x50 binoculars. Because of the isolation from the auditorium all signals to the operator for slide changes, etc., have to be given through a cue monitor system: two microphones, located on the lecturer's table, provide the necessary information to the operator through a mixer-adder amplifier. This closed circuit cannot be used for any other purpose than cuing from the lecture table, but an auxiliary cuing circuit is available from the audio console to the booth. This apparent duplication of cuing facilities may seem unnecessary, but in practice the cue signals provided by the console circuit enhance the general coverage of the auditorium, and are of great assistance to the projectionist when the lecturer wanders away from the usual lecturing areas. Communication between the chairman, console operator, and projectionist is carried out by means of sound-power telephones.

Lighting

The lighting circuits of the auditorium are controlled by the projectionist, but auxiliary controls have been installed at strategic positions to enable the console operator or chairman to control the lighting in the event that no projectionist is on duty.

Comments

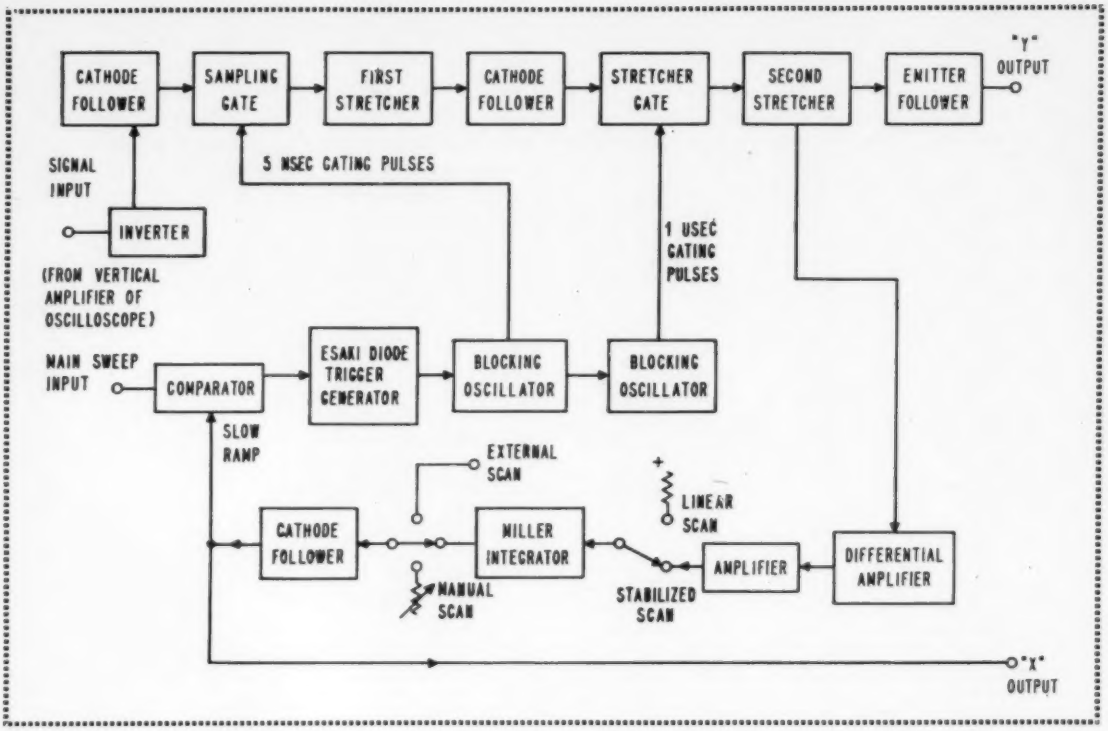
Recently, a transistorized radio microphone was incorporated in the voice reinforcement system to eliminate trailing microphone cables, which severely curtail or interfere with the activities of the speaker. The third audio channel (monitor) previously mentioned is utilized when necessary to feed two loudspeakers installed in the ceiling at the rear of the auditorium. A weak-voiced speaker can be amplified to normal hearing level in the rearward sections of the auditorium; at the same time, only slight voice reinforcement being required in the front area. This addition is particularly helpful when the speaker is making use of the chalk board or demonstrating slides or films, and facing away from the audience. The use of a high intensity light pointer has greatly enhanced the presentation of slides, in that exact clear positioning of the indicator arrow leaves no doubt as to the area of interest.

It has been found necessary to have a standby slide operator whenever automatic slide changers are in use; a mixture of glass, metal or cardboard slides invariably causes jamming in the projector.

All of these facilities have been in use during the past year, or more, and have been of particular value during symposia, conferences, and lectures. To date no facility has been overtaxed, and it is hoped that further demands will not entail any major circuit or structural changes. The circuits and systems are believed to have sufficient spare facilities for the future, and the flexibility of the over-all installation should prevent early obsolescence of the system.

END

"Don't tell me! You misplaced the decimal point again?"



Frequency translation aids plotting of fast repetitive waveforms 101

HARRY J. LEWENSTEIN, Hewlett-Packard Company, Palo, Alto, California.

Direct photographs of crt oscilloscope traces are valuable for a number of applications. However, the higher resolution and easy duplication of large-scale X-Y recordings are desirable for plotting families of curves and waveforms, for inclusion in reports, permanent test records and similar applications.

X-Y recordings of fast waveforms can be made by using sampling techniques which sacrifice time to gain bandwidth. These techniques also open the door to automatic waveform testing, which will be understood after a look at the block diagram.

Model 166C display scanner is a plug-in unit for Hewlett-Packard oscilloscopes models 160B (15 Mc) and 170A (30 Mc). It takes its input signal from the output of the oscilloscope main vertical amplifier. Five-nsec pulses from a blocking oscillator open a sampling gate, allowing the signal at that instant to be stored in a small capacitor in the first stretcher. A second blocking oscillator supplies 1-usec pulses to open a gate to the second stretcher in which a larger capacitor assumes a charge proportional to the signal. This second stretcher has a time constant long enough to allow operation with sampling rates as low as 20 cps. The Y-axis information is taken from this second stretcher through an emitter-follower stage.

Timing for the generation of gating pulses is accomplished in a comparator circuit, which senses coincidence between the oscilloscope main sweep and a slow ramp generated by a Miller integrator (when operating in the linear mode). At coincidence an Esaki diode circuit triggers the two blocking oscillators. In this manner, successive samples are taken slightly later on the waveform until the entire trace has been covered. A sample is taken at each re-occurance of the main sweep.

There are four methods of scanning provided in the instrument: linear, stabilized, manual and external. With the linear scan the slow ramp drives the carriage of the X-Y recorder at a constant rate in the horizontal direction. The speed of the pen, however, will depend upon the nature of the scope waveform and may be very fast when tracing portions with sharp vertical changes. To make sure that any waveform will be within the bandwidth of standard X-Y recorders, the speed of the linear scan has been set quite slow, requiring about 90 seconds for a complete presentation.

To permit faster scanning times, a stabilized scan circuit automatically regulates the speed of the carriage

and compensates for the rate of change of the pen. Thus, the carriage moves fairly fast in the horizontal direction when the pen is tracing portions of a waveform having little or no vertical change, but slows down when large vertical changes are encountered. The stabilizer circuit differentiates the vertical output signal and produces a voltage proportional to the vertical rate of change. This voltage is used to determine the slope of the scanning ramp.

The manual scan is controlled by a front panel potentiometer. The control is continuously adjustable and can be stopped at any point. It can even be reversed to retrace, and can be varied slowly enough to provide full detail.

In external scan, an externally applied voltage determines the point of sampling on a waveform. It could be a linear ramp . . . or a series of dc levels (staircase) which could be programmed to perform certain automatic testing functions. The vertical analog output could be digitized, and an entire testing function could automatically be performed.

Recording by a strip chart is possible when using the internally generated linear ramp, or an external linear signal. There are also techniques by which two Display Scanners can be synchronized to provide an X-Y presentation of two related signals for observation of phase relationship, harmonic relationships, and other criteria of comparison.

New radio design introduced to compete with low-cost imported products 102

Philips Electronics Industries Ltd., Toronto, has designed a circuit for a 5-transistor cordless mantel radio which is expected to retail for less than $30 in Canada.

A "package deal" of recommended components, including the transistors, is being offered by Philips at a special price to Canadian manufacturers, along with free schematics and production information.

A number of manufacturers are currently evaluating production economics of the new radio designed by E. H. Hugenholtz, chief of Philips' Tube & Component Applications Laboratory.

One marketing problem anticipated by Philips is consumer antipathy toward battery-operated products. Some people have experienced problems with pocket radios consuming expensive miniature batteries at a high rate.

The Philips cordless radio is designed to run up to six months of normal daily use on four standard D-size flashlight cells.

The radio is designed around Philips, alloy-diffused transistors which have high gain. These, and circuit innovations provide an output of 250 mw with only five transistors and three diodes.

A relatively high gain mixer (Q1) is used in conjunction with a single, high gain IF stage (Q2). The relatively low detector level makes it necessary to amplify the AGC derived from the first audio stage (Q3).

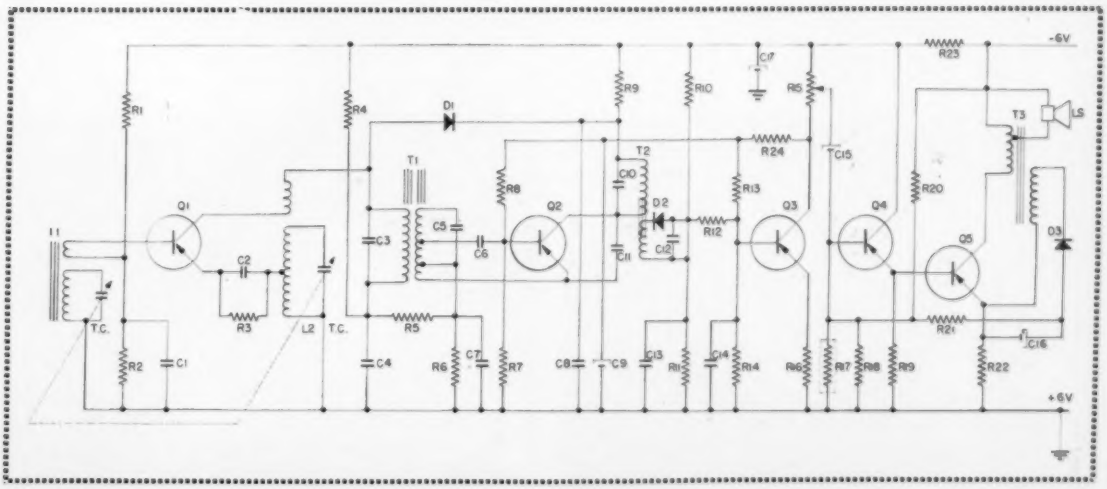
The base-emitter drive circuit used with Q2 incorporates self-neutralizing characteristics, as well as substantial negative feedback. This permits operation at levels only a few db below the limit of stability. In this manner, a higher effective gain can be achieved.

Q3 operates as an audio amplifier and d-c amplifier for the AGC. It is followed by two more stages, Q4 and Q5 in cascade.

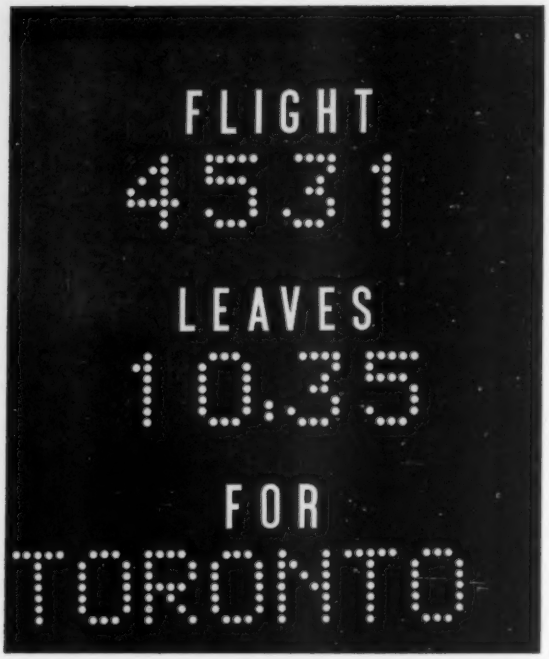
Diode D3 is used for a sliding bias control of the output stage (Q5). It reduces the current consumption of Q5 in class A operation.

D1 has a dual function. It acts as a d-c clamp preventing parasitic oscillation which could occur if the collector voltage fell below the base voltage level. Its secondary function is to increase the efficiency of the AGC.

Field strength sensitivity of the radio at 1,000 kc is 200 uv/m for 25 mw output. Bandwidth is 7.6 kc for 6 db, and 18 kc for 20 db. Image rejection is 45 db, and AGC is 100 uv to 100 mv for 10 db output variation. The output level is 250 mw at less than 6% distortion.



Magnetic matrices form display messages 103



Ferranti-Packard Electric Ltd., Toronto, has introduced a new system for visual display of variable information. Potential applications include arrival-departure and gate boards for transportation terminals, sport scoreboards, stock market quotation boards, and other displays of changing alpha-numeric information.

Each character module is composed of a disc matrix, five across and seven down. Each disc has a satin white reflective side and a black mat side. On the latter is affixed a small permanent magnet. Each disc is suspended on a diagonal nylon thread between the poles of a small electro-magnet. Depending on the poliarity of the electro-magnet, forces are set up on the permanent magnet field to rotate either the black or white side of the disc outwards. By choosing the proper polarities of each of the 35 electro-magnets in the matrix, any alpha-numeric character can be presented.

Magnetic matrix displays require negligible power for the presentation of new information, and no power at all to maintain an existing display. Characters in the illustration measure 3 x 4 inches, but other sizes can be made. A major advantage is the wide angle over which the characters can be read.

Various control systems for the displays are available, depending on the application, number and complexity of changes which must be made. The simplest system uses toggle switches on a manual control board. Elaborate systems can be equipped with automatic input.

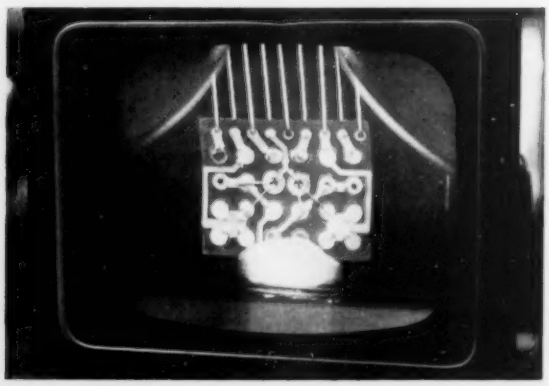
Television comparator permits examination and measurement of miniature objects 104

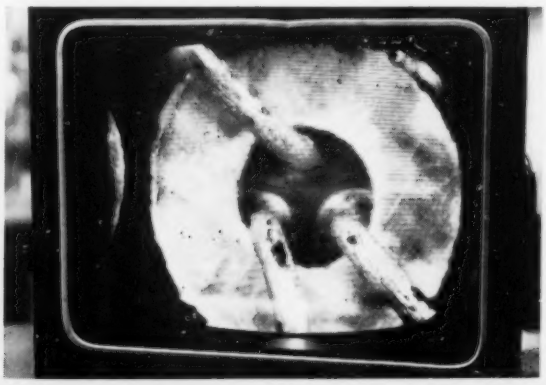
A new television comparator that permits examination and precise measurement of miniature solid objects, with magnification up to X300, has been introduced by the GPL Division of General Precision, Inc.

The closed circuit TV system permits an operator to inspect and examine, in minute detail, components such as transistors, resistors, diodes, instrument parts, and other small assemblies.

Using a single aircraft-type control stick, an operator can position the image on the screen, and change its magnification through the entire range without loss of focus.

The picture on the left shows a microminiature wafer magnified seven times. The leads running into the transistor bases in the centre of the picture are 0.010 inch diameter. In the picture at the right, the leads and surrounding detail have been magnified 80 times.





Canadian solid-state nuclear detector enters world markets

Last year RCA Victor announced successful development of its solid state alpha particle detector. To date, they have received requests for the device from 23 countries.

The silicon junction detector was the world's first practical solid-state charged particle detector. It was developed at the Montreal Research Labs of RCA Victor, and was a project undertaken in co-operation with the Electronic Component Research and Development Committee of Defence Research Board.

The device functions as a solid-state ionization chamber, and can be used to monitor protons and beta particles as well as alpha particles.

Twenty four types are in production now with additional types available on special order. The response of the detectors to high energy particles has been improved and they can now measure proportionally alphas up to 40 Mev. Voltage ratings have also been stepped up from 50 to 400 volts, and pulse height measurement is now possible to better than 0.5% accuracy.

In Montreal, RCA Victor's research scientists are working on more sensitive versions of the detector. Projects include development of solid-state detectors with high efficiency in detecting other nuclear particles, and continued improvement of various types of solid-state infra-red detectors.

ISA elects officers for 1961-62

Officers for the year 1961-62 were elected last month by the Instrument Society of America, meeting in Los Angeles in conjunction with the Society's 16th Annual Instrument-Automation Conference and Exhibit.

Assuming the presidency of the Society after serving a year as President-elect-Secretary, is Philip A. Sprague, Michigan City, Ind., president of The Hays Corporation of that city. He succeeds Dr. Ralph H. Tripp, Huntington, N.Y., assistant director. Flight Test, Grumman Aircraft Engineering Corp., Bethpage, L.I., N.Y.

Nathan Cohn, Philadelphia, vice-president of Leeds & Northrup Co., was named President-elect-Secretary, moving him into position for the post of the 1962-63 president of the Society.

Named as Vice-President-elect of ISA's Standards & Practices Department, is John R. Mahoney, Oak Ridge, Tenn., a superintendent at the Union Carbide Nuclear Plant there.

Dr. Benjamin W. Thomas, director of Instrumentation Physics Research, Texas Butadiene & Chemical Corp., Baytown, Texas, was chosen Vice-president-elect of the Technical Department of the Society.

NRC scientist joins McGill University

Dr. J. H. Milsum, head of the analysis and computation group, National Research Council, has left to join the staff of McGill University. He occupies the new Abitibi Chair of Control Engineering.

Dr. Milsum's duties are to head up a program of teaching and research in automatic control and other computation techniques. While his section is part of the Electrical Engineering Department, projects will include interdisciplinary studies, for example on social and biological problems.

Dr. Milsum joined NRC in 1950 to do special research on aircraft icing. He went to the Massachusetts Institute of Technology in 1954, returning to NRC in 1957 to become head of the analysis section in the division of mechanical engineering. He is a member of NRC's associate committee on Automatic Control which was formed in 1959.

Milsum

Hobley

RCA Victor engineer wins British award

A member of the engineering staff at RCA Victor in Montreal has been awarded the highest honor for a technical article by the Society of Licensed Aircraft Engineers. The Society awarded the 1960 Gold Badge to Mr. P. Hobley, A.M.S.L.A.E., presently Manager of the Instrument Services Department of RCA Victor.

The award is made annually for the most outstanding paper published in the Society's journal, and this is the first time it has gone to a member resident outside Great Britain. Mr. Hobley's article was entitled "An introduction to the Reliability Concept", and has been reprinted several times and circulated throughout the world.

As well as describing the use of reliability concept methods in the field of electronics, the paper studied the practical application of such methods to electro-mechanical and mechanical components.

The development of the special prediction methods described in the paper was performed while Mr. Hobley was a member of the Reliability Control Section of Defence Systems Engineering at RCA Victor.

Chemical engineering conference

The Chemical Engineering Institute of Canada will hold its Canadian Chemical Engineering Conference at the Royal York Hotel, Toronto, November 6-8, 1961.

This is a brief summary:

Session A: Process design.

Session B: General papers on chemical engineering science.

Session C: General papers on chemical engineering practice.

Session D: Digital computers

Session E: Kinetics of catalytic reactions

Session F: Panel discussion on graduate research in our Canadian chemical engineering schools.

Session G: Chemical engineering aspects of nuclear engineering.

In addition, there will be plant tours, and the R. S. Jane Memorial Lecture, to be delivered by G. K. Blaikie, Shawinigan Chemicals Ltd.

Full details about the conference may be obtained by writing to the Chemical Institute of Canada, 48 Rideau St., Ottawa.

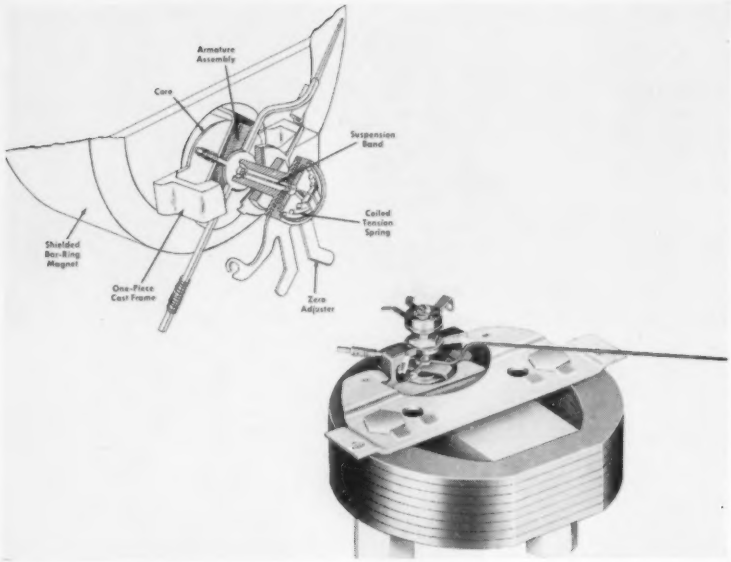
Scientists discover new particle of matter

The discovery of a new elementary particle of matter which gives important insight into the structure and behavior of the atomic nucleus was announced last month by scientists in the University of California's Lawrence Radiation Laboratory in Berkeley and by the United States Atomic Energy Commission.

The particle is the omega meson. It plays an important role in the structure of protons and neutrons, the basic building blocks of atomic nuclei. The mass of the omega is 1540 electron masses. Like the neutron, the omega has no electrical charge.

Some 30,000 photographs were analyzed. In 90, analysis showed that the presence of omega was essential to explain the observable phenomena.

New instruments



Panel meter has sensitive suspension 105

This Triplett meter is designed for high accuracy without friction error or suspension wire fatigue effect. Heart of the meter is a short, extremely thin platinum wire kept tightly suspended on special spring terminals to support the coil and its moving counter-parts. Conical shaped spring anchors provide resilience for the taut suspension wire when the instrument is subjected to shock from any direction. The new suspension is being incorporated in a number of different meters.

Len Finkler Ltd., Toronto.

Function generator aids test programming 106

Two Vernistat adjustable function generators have been fitted to a Marquardt automatic programmer used to control a test machine for subjecting materials to simultaneous physical loads and high temperatures. Basically, the function generator is a voltage control device with its output voltage proportional to the vertical displacement of sliders on a grid. Each of the sliders is individually adjustable, allowing rapid, precise setting for any mathematical or empirical function, including those with multiple slope reversals. Each slider is adjustable to any of 101 positions, providing (in this application) 34 voltages, each within ±0.5% of any required value. The 34 sliders positioned on the rectangular coordinate arrangement of the two function generators provide a graphic display of the output voltage versus time from the start of the program.

Perkin-Elmer (Canada) Ltd., Montreal.

Smoke recorder 107

Photomation smoke recorder is a null-balance potentiometer with rapid traverse and adjustable sensitivity. If complete coverage from clear to blackout is desired, this covers the entire chart graduated from 0.100. Also available are charts graduated from 0-100 with Ringelmann numbers. If it is desired to read more accurately the good combustion hazes, optimum haze may be set at "50" on chart and desired limits on either side.

Canadian Biotronics Corp. Ltd., Montreal.

Voltage calibrators 108

Calibration Standards Corp. voltage calibrators will measure and supply voltage to 0.05% (model VC-100A) and 0.01% (model VC-200A). Voltage ranges 0-1, 0-10, 0-100, 0-1000 volts are incorporated with infinite input resistance at null on all ranges. Null sensitivities are 100 v, 10 v, 1 v, 0.1 v and 1 mv (full-scale) for both instruments. The instruments give a digital readout presentation.

Aviation Electric Ltd., Montreal.

(Continued on page 59)

New components

Packaged electronic circuits 109

A group of 31 new packaged electronic circuits is now available to the replacement market. They include 3 vertical integrators, 2 tone control networks, 1 video and 3 audio coupling networks, a phase comparator network, a flip-flop network, 2 yoke balancing networks, and other specialized circuits. The new units have been given the part numbers from PC-371 through PC-404.

Centralab Canada Ltd., Ajax, Ont.

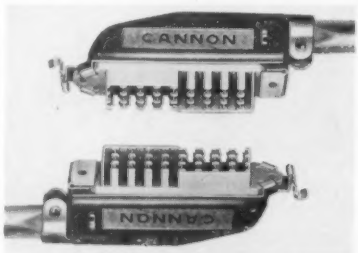
Trimming potentiometers 110

A new mono-crystal-thick film with stable temperature characteristics which permits construction of trimming potentiometers with long life, high power and infinite resolution, has been developed by Atohm Electronics. The new potentiometers are available in the ohm to megohm range.

Precision Electronic Components (1956) Ltd., Toronto.

Plug for telephone cables 111

Morpho 51 is designed to connect inside telephone cables. Because of the flat, elongated shape, the plug extends out from the surface of a wall or ceiling to a dimension equal to the thickness of the connected cable. Generally, the plug can follow the cable into any area where installation is required. Lexan is used as the insulation material providing a high temperature material which is stronger than cellulose acetate. Each receptacle will accommodate up to 51 crimped contacts.



Cannon Electric Canada Ltd., Toronto.

Computer diode 112

Microwave Associates, Inc., has introduced a high speed silicon point contact computer diode for applications requiring fast switching speed and response. Reverse recovery time of the MA-4121 diode is a fraction of a nanosecond and is governed primarily by the wiring configuration. The junction capacitance measured at 0 volts bias is 0.50 pf (maximum). The unit is packaged in a standard subminiature glass case with a

diameter of 0.105 in. (maximum) and a length of 0.300 in. (maximum). Forward characteristics are 10.0 milliamperes at 0.55 volts (maximum) and 30.0 milliamperes at 1.0 volt (maximum). The maximum reverse current is 200 microamps at -4 volts.

E. G. Lomas, Ottawa.

Precision servo potentiometers 113

This new series of commercial precision servo-potentiometers features three models initially, all with anodized aluminum cases and centreless-ground stainless steel shafts. Available with servo mountings or standard bushings, the potentiometers can be ganged to at least five sections. Resistance range, power rating and linearity tolerance of the three models are: model 9, 50 k, 1 watt (100 deg C), ±0.25%; model 15, 250 k, 2 watts (100 deg. C), ±0.1%; model 20, 400 k, 4.5 watts (100 deg C), ±0.1%.

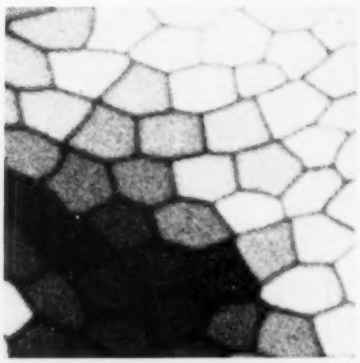
Hoffman Electronics Corp., Los Angeles.

To obtain further information on these products, use the Reader Service card on page 69.

Fiber optics crt 114

Allen B. Du Mont Laboratories have developed a series of cathode-ray tubes with fiber optical face-plates which permit images to be brought directly to the outside surface of the face-plate so that all parallax is eliminated. Normal light transmission efficiency of about 6.3% using a lens system is increased to 85-90% using fiber optics.

The first types available are K2160, which is a magnetic focus, magnetic deflection tube with a 1 mil line width; K2159 with combined magnetic and electrostatic deflection and electrostatic focus; K2155 with magnetic deflection



and low voltage electrostatic focus. All are 1-7/16 inch diameter tubes, but larger sizes can be provided.

Bayly Engineering Ltd., Ajax, Ont.

(Continued on page 62)

New equipment

Clock inverter 115

Model A40 is a new, frequency-stable, solid state dc to ac inverter which provides a 115-volt, 60 cps square wave output from a 10 to 15 vdc input. The output of the inverter drives a built-in digital clock, and up to seven external clocks. The unit is designed to serve as the master frequency source for synchronized clock systems in such applications as broadcasting studios, industry, schools and offices. Its small size and low power drain make it useful for mobile applications. Accuracy of model A40 is better than 1 part in 10^6, or less than 1 second error per 10 days, over the specified input voltage range, no-load to full-load.

Tele-Radio Systems Ltd., Toronto.

Dehydrating air supply 116

Kahn KC-1114 dehydrating air supply is designed to deliver a continuous supply of clean, dry air without the need for a heater for dessicant reactivation. It can be used for purging electronic components, and for pressurizing wave guides, transmission lines and dry boxes. Flow rate is 50 cu in. per min; delivered pressure is 2 psig; drying performance is —44 C dew point; power requirement is 208 or 220 v, 60 cps, single phase.

F. W. Chambers & Co. Ltd., Toronto.

Fatigue testing power amplifier 117

This power amplifier was designed for use with fatigue testing equipment. A transducer converts audio frequency power to a mechanical vibration. Power input to the amplifier is 115 v, 60 cps, 2.5 kva. The required audio input (from the oscillator) is 5 v rms maximum into 500 ohms. The amplifier is usable over a frequency range of 20 to 10,000 cps. While the nominal output rating is 750 watts maximum, the available power varies with frequency.

R. H. Nichols Ltd., Downsview, Ont.

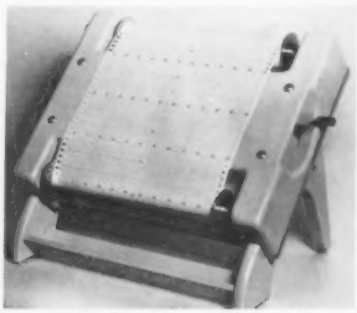
Thermoelectric driers 118

This drier is a thermoelectric device for suppressing the dew point of air and gases. It consists of a baffle system with Frigistors mounted on the outside of the heat exchanger and vapor trap. Frigistors are tiny semiconductor cooling elements. The drier is designed for baffles to operate at or near 0 deg. C. Effectiveness down to —30 C has been obtained.

Needco Cooling Semiconductors Ltd., Montreal.

Chart inspection scanner 119

This portable scanner for inspecting recording charts, will take rolls in any width to a maximum of 12¼ inches, in lengths up to 120 feet. A single handle winds the roll in either direction. The chart may be slipped on and off the spindle without the need for a core. The



scanner has been built to take adapters, which will be produced in the future, for fine reading, enabling measurements to be made in 0.001 inch increments.

Staebler & Baker Ltd., Gananoque, Ont.

Compandors 120

These provide a means of improving signal/noise ratio of a circuit which would otherwise suffer from excessive noise or crosstalk. Compressor input range is 0 to -60 dbm; output range is 0 to -30 dbm; compression ratio is 2:1. Expandor input range is 0 to -30 dbm; output range is 0 to -60 dbm; expansion ratio is 1:2.

Etelco Canada Ltd., Scarborough, Ont.

(Continued on page 64)

People — continued

W. E. Connelly, MBE, and H. E. Walsh, MBE, have retired from the Transport Department's Telecommunications Branch.

Connelly

Walsh

Mr. Connelly, 67, was superintendent of common carrier and landlines. He spent World War I in the Naval Service and joined the Department of Transport (then called Marine and Fisheries) in 1919.

During the latter part of his service, Mr. Connelly has been active in the nationalization of the commonwealth telecommunications system, the forming of the Canadian Overseas Telecommunications Corp. and the work of the International Telecommunications Union.

He received an MBE in 1946 in recognition of his active participation in the development and operation of a training program for staff engaged in wartime detection work.

Mr. Walsh, 65, was chief of the design and construction division. He served with the Army, and later the Navy during World War I. Then he returned to the University of British Columbia to earn his BASc degree in electrical engineering in 1925. (He earned his BA degree there in 1916). He joined the Department in 1925.

He was honored with an MBE in 1946 in recognition for his direction of the establishment of aviation navigation radio aids during World War II to serve the requirements of home defense and Commonwealth training. He was also awarded the Coronation Medal in 1953.

Mr. Walsh is a member of IRE and the Professional Institute of the Public Service.

Spencer W. Caldwell has been named a Fellow of the Society of Motion Picture and Television Engineers.

Mr. Caldwell, president and founder of CTV Television Network Ltd., Toronto, is a past president of the Association of Motion Picture Producers. He is a director of the Association of Cinema Laboratories, and a member of the Toronto Board of Trade. He was one of eighteen members elevated to Fellow Membership status.

Reports — continued

BBG will consider licensing new radio stations in major cities

In its hearings during 1960, for second television licenses in several cities in Canada, the Board of Broadcast Governors, as a matter of policy, announced that it would not recommend licenses for additional AM and FM radio stations in those cities until the second TV stations were on the air and their effects on the markets were apparent.

The BBG has now announced that it will consider AM and FM applications in all eight cities affected after January 1, 1962. New applications will be considered, along with those pending since 1960.

Electronics firms establish new facilities and change addresses

Canadian Research Institute has appointed Alfred Lunge Montreal manager responsible for all sales in the province of Quebec. He is located at 4554 Patricia Ave., Montreal 28.

Radionics Limited has appointed Edward S. Zieba as field sales engineer for the Toronto and Western Ontario area. His headquarters are in Toronto — P.O. Box 9, Downsview, Ont., telephone 368-4071. Mr. Zieba is a graduate of Queen's University (electrical engineering) and has been employed by Canadian General Electric.

The head office of **Burroughs Business Machines Ltd.** is now at 443 University Ave., Toronto 2. Telephone: 362-6641. The quarters vacated at 752 Bay St. have been taken over by the Toronto Branch sales and service organizations. Telephone number is unchanged: EM 3-3001.

Changes in street numbering along Kipling Avenue have resulted in a new address for **W. H. Brady Co. of Canada Ltd.** They now report their location as 1422 Kipling Ave. North, Rexdale, Ont. The telephone number is (Toronto exchange) 249-8531.

Company changes name to keep in step with new operations

Winco Electronics Co. Ltd., Windsor, has changed its name to Industrionics (Canada) Ltd. The new name is more descriptive of its present operations and planned diversification. They rebuild TV picture tubes and market them under the name of Winco.

New company enters printed circuit field

Graphico Precision Works Ltd., 74 Mack Ave., Scarborough, Ont. (telephone OX 9-7169) has facilities for producing printed circuits, doing chemical milling and electroplating.

Ottawa—continued

on the buyer's desk, until it has UL approval it means little more to him than a gleam in the manufacturer's eye".

Head office of UL is at 207 East Ohio St., Chicago, and there are also testing stations at 2250 Dundee Rd., Northbrook, Ill.; 161 Sixth Ave., New York, N.Y., and 1655 Scott Blvd., Santa Clara, California.

A proposed product should go to the UL head office with complete description, purpose, size, rating, etc. Certain types of equipment are only tested at particular stations but will be forwarded accordingly by the UL head office.

The manufacturer in return will get a copy of UL standards and an application form specifying the cost limit of tests, estimate of time needed, responsibility of the laboratories and so forth.

In cases of disagreement the manufacturer can appeal to the National Bureau of Standards.

Although UL has set up an office in Canada, approval of this body is not valid in the U. S. nor is that of the Canadian Standards Association.

Manufacturers of electrical and electronic apparatus have made a slight reduction in their capital spending plans for 1961.

This compares with a small increase from earlier estimates for all types of secondary manufacturers.

The Department of Trade and Commerce report "Public and Private Investment, June, 1961" shows that electrical and electronic manufacturers have cut their original expenditure estimates for this year by $900,000.

There is no change in forecast spending on new construction, which remains at $7.9 million, but spending on new machinery and equipment will be cut by $900,000 to $24.6 million.

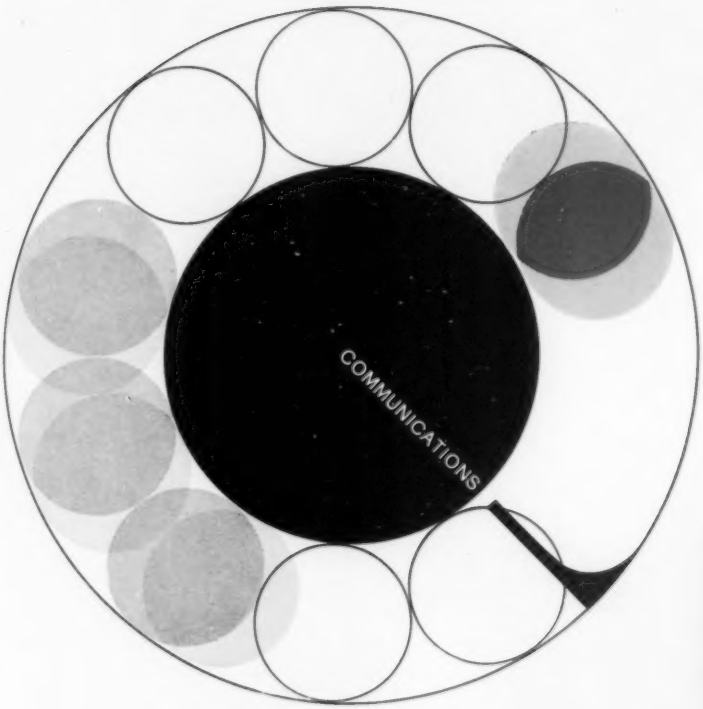
Despite the drop total capital spending in 1961, at $32.5 million, will be a fraction higher than that in 1960.

Agents and lines wanted

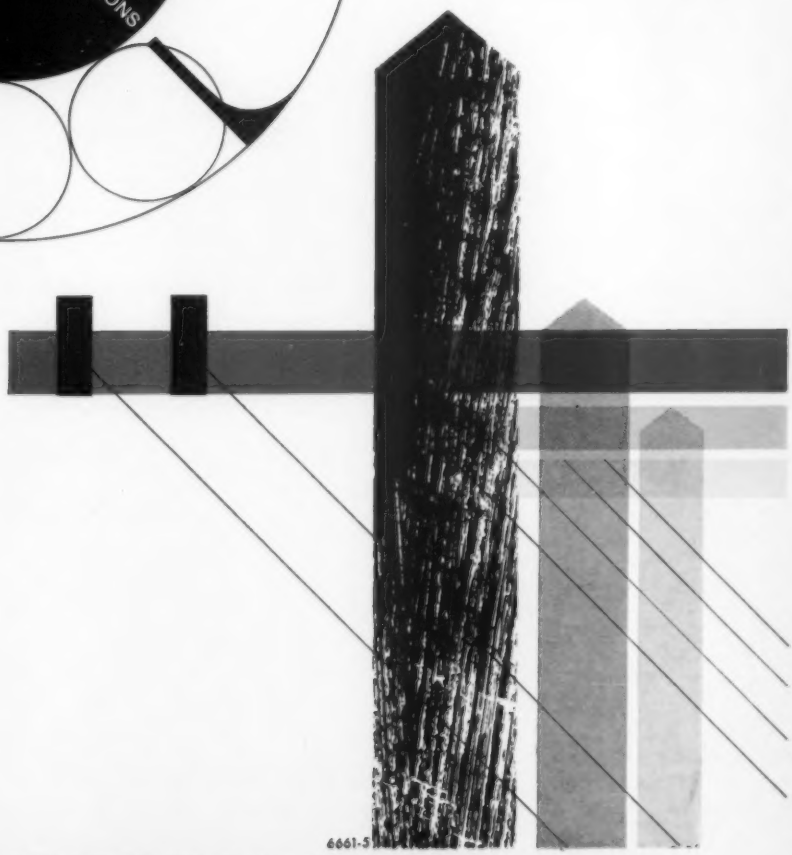
Emerson Short, 1156 Beechwood, North Vancouver (YU 7-5565 and RE 8-9230) is interested in representing manufacturers of electronic equipment. He is in a position to cover Western Canada, handling products and equipment associated with radio, TV, broadcasting, Hi-Fi, communications and recording.

SERVING CANADA THE NORTHERN WAY

The aim of Northern Electric Engineers is to continue to design and manufacture the finest in Communication equipment. Northern's research facilities and manufacturing capabilities are unexcelled in this field in Canada. Northern Electric designs, manufactures and installs a large proportion of Canada's telephone communication systems and equipment. It includes the manufacture of electrical wires and cables for communications and power transmission, and the distribution of a complete line of electrical apparatus and supplies. At Northern Electric, product research and development never stops and continuing progress is made in the communication, electrical wire and cable fields.



Northern Electric
COMPANY LIMITED



6661-5

For further information mark No. 42 on Readers' Service Card

METOX

insulated power resistors

Welwyn

- **HANDLE MORE WATTS PER SIZE.** This is particularly so in the higher resistance values.
- **OFFER HIGHER RESISTANCE RANGES PER SIZE.** For example, up to 47K in the 4W F32 size.
- **ARE VIRTUALLY NON-INDUCTIVE.**
- **INSURE RELIABILITY.** Comprehensive tests have proved that operating these resistors under the most arduous conditions will not cause failure.
- **HAVE SUPERIOR SURGE AND OVERLOAD PERFORMANCE.** The application of ten times the rated load for 5 seconds results in a typical resistance change of less than 0.5%.
- **A PRICE AS COMPELLING AS THE PERFORMANCE . . .** Resulting from control and efficiency in manufacture.

UNIQUELY DIFFERENT AND RADICALLY NEW!

The Welwyn F Series power resistors are composed of a metal oxide element, bonded to a porcelain rod at red heat. This process results in a resistor which is extremely rugged, both electrically and mechanically. The durable coating is intended to provide an insulating cover rather than to protect the element which in itself is highly resistant to mechanical damage and effects of moisture.

WELWYN TYPE DESIGNATION	MAXIMUM LENGTH	POWER RATING	RANGE OF VALUES*
F32	29/32 inches	4 Watts	20 ~ to 47K
F33	1-5/16 inches	6 Watts	30 ~ to 56K
F34	1-23/32 inches	8 Watts	40 ~ to 68K
F35	2-3/32 inches	10 Watts	50 ~ to 75K

*Rated Wattage may be dissipated up to that resistance value set by a potential limitation of 500 V/inch.
Where less than full Wattage is involved, potentials up to 1000 V/inch may be applied.

Welwyn Canada Limited
1255 BRYDGES ST., LONDON, ONTARIO

For further information mark No. 58 on Readers' Service Card

Defence contracts

Unclassified electronics contracts for $10,000 or more have been awarded to the following Canadian firms by the Department of Defence Production. A figure in parentheses indicates the number of contracts, the amount being the total value.

August 1-15, 1961

- Alberta Government Telephones, Edmonton, installation of telecommunication equipment and associated on-base cabling, $52,518.
- Bell Telephone Co. of Canada, Ottawa, lease of communication circuits, $11,177; installation of telecommunication equipment and associated on-base cabling, $72,569.
- Canadian Arsenals Ltd., Ottawa, anti-jamming consoles, $271,184.
- Canadian General Electric Co. Ltd., Toronto, tubes, $89,892 (2).
- Canadian National Railway Co., Ottawa, lease of communication circuits, $211,084 (4).
- Canadian Westinghouse Co. Ltd., Ottawa, tubes, $75,337.
- Computing Devices of Canada Ltd., Ottawa, components, $108,792; radio sets, $256,296.
- Electronic Materiels International Ltd., Ottawa, components, $11,149.
- Anthony Foster & Sons Ltd., Toronto, direction finder sets and equipment, $56,415.
- Joy Mfg. Co. (Canada) Ltd., Galt, Ont., cable assembly and connector plugs, $23,547.
- Laval University, Quebec, computing services, $14,000.
- Marsland Engrg. Ltd., Kitchener, Ont., modification of range recorders, $17,311.
- Northern Radio Mfg. Co. Ltd., Ottawa, frequency modulated voice frequency carrier telegraph terminal, $343,293.
- Phillips Electrical Co. Ltd., Ottawa, buried telephone cable and accessories, $349,220.
- Picker X-Ray Engrg. Ltd., Toronto, medical equipment, $12,700.
- Renfrew Electric Co. Ltd., Renfrew, Ont., coaxial adapter sets, $13,927.
- Spartan Air Services Ltd., Ottawa, radar altimetry by airborne profile recording, $170,859.

August 16-31, 1961

- Alpha Aracon Radio Co. Ltd., Downsview, Ont., capacitors, $10,617; associated equipment and tools for antenna, $11,937; components, $18,613.
- Ampex of Canada Ltd., Ottawa, tape transport unit, $10,621.
- Argon Welding Industries Ltd., Lachine, Que., spares for communication equipment, $15,136.
- Aviation Electric Ltd., Montreal, aircraft instruments, $13,497.
- Bell Telephone Co. of Canada, Ottawa, lease of communication circuits, $831,048 (8); installation of telecommunication equipment and associated on-base cabling, $105,771.

- Canadian Arsenals Ltd., Ottawa, anti-jamming consoles, $293,628.
- Canadian General Electric Co. Ltd., Toronto, components, $32,632.
- Canadian National Railway Co., Ottawa, lease of communication circuits, $29,841.
- Canadian Pacific Railway Co., Ottawa, lease of communication circuits, $41,975.
- Canadian Westinghouse Co. Ltd., Ottawa, mortars, $121,975; technical assistance in conducting investigations of torpedo performance, $20,000.
- Paul Chaput Ltee, Montreal, loudspeakers, $14,549.
- Garrett Mfg. Ltd., Rexdale, Ont., technical representative, $13,262.
- Honeywell Controls Ltd., Toronto, technical representatives, $56,736.
- Instronics Ltd., Stittsville, Ont., equipment, $11,915.
- Lionel Electronic Labs., Ajax, Ont., maintenance spares for radiation equipment, $13,175.
- Northern Electric Co. Ltd., Ottawa, communication equipment, $25,653.
- Northern Radio Mfg. Co. Ltd., Ottawa, frequency modulated voice frequency carrier telegraph terminal units, $15,214.
- Patlon Aircraft of Canada Ltd., Toronto, components, $21,822.
- RCA Victor Co. Ltd., Ottawa, unidirectional high frequency antenna, $137,277.
- Raytheon Canada Ltd., Waterloo, Ont., radar sets, heat exchangers and prime power units, $1,609,680.
- Safety Supply Co., Toronto, noise excluding headphones, $129,354.
- Sperry Gyroscope Ottawa Ltd., Ottawa, telephone sets, $26,750.
- Stewart-Warner Corp. of Canada Ltd., Belleville, Ont., spares for maintenance platforms, $16,717.
- Sylvania Electric (Canada) Ltd., Montreal, tubes, $81,200.
- TMC (Canada) Ltd., Ottawa, equipment, $12,867.
- Valeriote Electronics (Guelph) Ltd., Guelph, Ont.. antennas, $13,209.

New instruments—cont.

Random signal generator 121

Servomex Controls type RG77 random signal generator employs a gas tube as the source of random voltage fluctuations and has a flat spectrum over the audio band. Part of this audio band is filtered off and passed through a non-linear element so as to form sum and difference frequencies. Since the input has a continuous spectrum, the difference frequencies extend (in theory) down to zero frequency; a low pass filter is used to remove the original band and the additional terms, leaving the desired low frequency noise. The frequency range of this unit is 0.04 to 10 cps with a sensibly uniform power per unit bandwidth; output voltage is 0 to 3 volts rms, the output current being up to 10 ma peak without overloading.

The Glendon Instrument Co. Ltd., Scarborough, Ont.

(Continued on page 61)

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ANALYSIS OF BISTABLE MULTIVIBRATOR OPERATION *by P. A. Neeteson.* This text, based on the Eccles-Jordan flip-flop circuit, is of great interest to electrical engineers working with bistable electronic trigger devices. .... For the computer engineers, it is 'must' reading. The author shows how it is possible to analyze the complete trigger cycle with fairly close approximation to practice, making use of two fundamental tools: the operational calculus and a few thearems about sudden closing or opening of switches in networks.

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MAGNETRONS *by Dr. K. Hinkel.* An invaluable source of information to engineers in the field of microwave and for those who must design or work with magnetrons. An extremely thorough analysis of the magnetron and test circuits. Complete with graphs and formulas, the text provides an extremely penetrating analysis of the operation of the magnetron. The engineer will find this text an enlightening work on the properties of magnetrons as well as their physical background.

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CONDUCTANCE CURVE MANUAL. GM curves of preferred type vacuum tubes. A companion to Conductance Design of Active Circuits. Stiff cover, **$4.25**

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VIDEO TAPE RECORDING, *Julian Bernstein,* cloth, **$8.95. UNDERSTANDING MICROWAVES** (abridged reprint) *V. J. Young, Ph.D.* **$3.50. BASIC ULTRASONICS, (Pictured-Text' Course)** *Cyrus Glickstein,* soft, **$3.50,** cloth, **$4.60. MAGNETIC AMPLIFIERS—Principles & Practices,** *Paul Mali* **$2.45. BASIC CARRIER TELEPHONY ('Pictured-Text')** *David Talley, E.E.,* soft cover, **$4.25;** cloth, **$5.75.**

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ENCYCLOPEDIA ON CATHODE-RAY OSCILLOSCOPES & THEIR USES (2nd Ed., Rev. Enl.) *J. F. Rider & S. Uslan.* Comprises a breathtaking cross section of oscilloscopes and their uses in every conceivable field and application. 1360 pages, 8½" x 11", cloth, **$27.00.**

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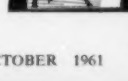

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Text presents fundamentals for analysis of circuits

Electronic Circuits, Signals and Systems

Samuel J. Mason and Henry J. Zimmerman; John Wiley & Sons, Inc., New York; 1960; 616 pp.; $12.50.

The increasing diversity in the engineering application of electrical science has resulted in university curricula which subordinate current technology to fundamental principles and methods of analysis. This book is one in the new series of undergraduate texts developed to support such a "core curriculum" at MIT. It presents the basic techniques for the analysis of circuits and signals in communication systems.

The methods of analysis begin with the representation of networks using matrix algebra, and the topological relationship between the transmission of a network and its structure. These are intended to supplement the more conventional methods which are assumed to be familiar. The signal-flow graph method of analysis is then deveoped and applied to a variety of electronic circuit problems. This is a powerful practical technique which not only reveals the signal paths in the simplest system, but also enables complex circuits to be solved by inspection.

In the analysis of signals, Fourier and correlation methods are applied to periodic, pulse and random signals. Considerable care is taken to convey an intuitive grasp of the significant characteristics of signals and their spectra. Finally, the transmission of signals through systems is analyzed in the form of the system response. This is done extensively for linear systems with some introduction to time-varying, non-linear modulation and negative-feedback systems.

This is a very readable text and the authors have tried with considerable effort to teach the fundamental ideas without becoming submerged in mathematical technique, as shown by the innumerable illuminating diagrams and sketches. A large number of problems are included, although few of the problems and none of the examples used are numerical. Students who include the material of this text in their undergraduate training will have a good basic grounding in methods of analysis for electronic systems.

Reviewed by H. C. Ratz, Assistant Professor of Electrical Engineering, Computer and Control Systems Laboratory, University of Saskatchewan.

Introduction to the Statistical Dynamics of Automatic Control Systems

V. V. Solodovnikov; Dover Publications, Inc., New York, 1960; 305 pp; $2.25.

This book was one of the first comprehensive treatments of the dynamics of linear control systems whose input signals are characterized in statistical terms. Although the original Russian edition was published in 1952, this translation will be found to be of current interest.

One of the conventional ways to characterize a servomechanism is to describe its response to one of the standard test signals such as the unit step function, the unit impulse, etc. However, there many practical cases in which the input signals to an automatic control system are not prescribed functions of time but vary instead in a random manner with only the statistics being given.

The book begins with a clear but condensed review of the frequency characteristics of dynamic systems, including approximate methods for calculation. Similarly, the necessary probability theory, including distribution and correlation functions, spectral densities, etc., are summarized. These ideas are then applied to the dynamic system analysis of linear feedback systems with stationary random input signals. Methods are given for approximating spectral density functions so that the analysis may be carried out in practical cases using experimental data. Then the synthesis of the optimum transfer function (minimum mean-squared error) for linear systems is determined. This leads to the general synthesis problem of optimum statistical prediction and smoothing. Finally, the case is treated when a presribed function of time is included with the random component.

A distinctive feature of this book is the close mixture of theory and practical application. The subject is naturally mathematical, but the mathematical theory is used only to express the ideas which are frequently applied to very practical examples. The question of how to use the analytical ideas is never left unanswered and graphical methods are employed when needed. Of course, recent work

For further information mark No. 30

in the field is not included; this is especially obvious in the non-linear cases. Nevertheless, the book will be useful as a text or reference because of the combination of concise presentation of fundamentals with methods of practical application.

Reviewed by H. C. Ratz, Assistant Professor of Electrical Engineering, Computer and Control Systems Laboratory, University of Saskatchewan.

New instruments—cont.

Tube tester kit 122

Starkit model 12-22 universal tube tester is available in either kit or wired form. It can be used to test European and North American tubes, industrial rectifier tubes, gas filled and starter tubes, transistors and diodes. An adapter enables the operator to check tv picture tubes. Operating voltages are applied to all elements, and an ac signal is applied to the control grid of a tube under test to check dynamic mutual conductance.

Stark Electronic Sales Co., Ajax, Ont.

DC voltage calibrator 123

DC voltage calibrator, the Laboratory Volt-Cal, made by Dynage Inc. has an accuracy of 0.1% over the temperature range of 6 C to 40 C. Three models give outputs of 0-10 mv, 0-100 mv and 0-1000 mv, over a 1000 division dial with an input of 94 to 140 vac. Battery powered versions are available.

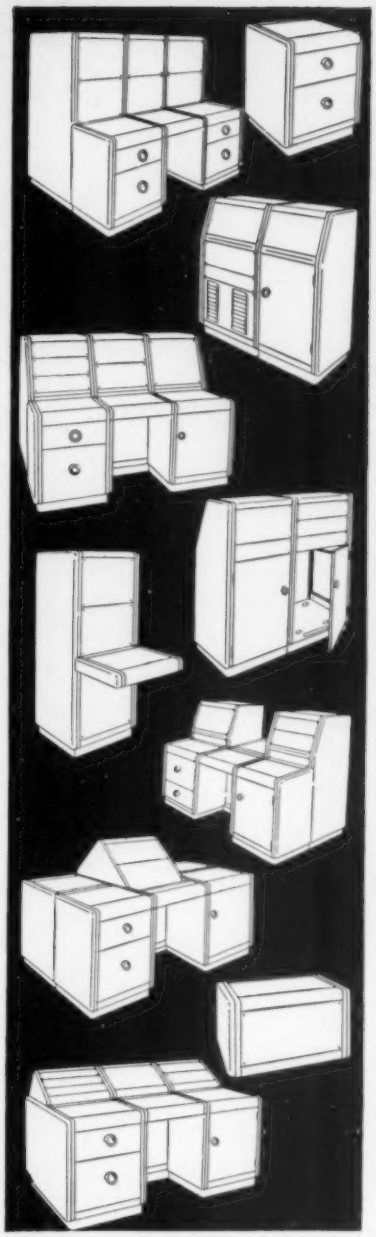
Canadian Research Institute, Don Mills, Ont.

Bar graph display oscilloscope 124

Profile monitor model 220 is a bar graph oscilloscope for continuous and simultaneous display of 48 input channels. The instrument provides an accurate, easily interpreted, visual display of any phenomena measureable by an electrical output. Selective vertical gain sensitivity, zero suppression control, automatic alarm system, and an electronic calibration grid line add to the versatility.

Advanced Technology Labs., Mountain View, Calif.

(Continued on page 62)



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New components—cont.

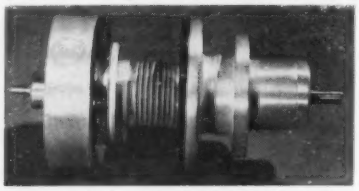
Welded seal button capacitors 125

Sangamo Electric has introduced a new welded seal button mica capacitor which permits operation at higher ambients. This also allows high temperature soldering techniques for easy circuit installation without risk of damage to capacitor seals. Each unit is fully liquid impregnated for protection against corona and will exceed the requirements of MIL C-10950B. Capacitance values up to 1,500 pf are available at 500 wvdc in a variety of mounting configurations.

David R. Beattie, Toronto.

High vacuum variable capacitors 126

The English Electric Valve Co. has started manufacturing commercial high vacuum variable capacitors. Five units comprise the range, three with capacitances of 5-30, 8-50, 16-80 pf, and two with capacitances of 5.5-206 pf. The peak rf voltage is 15 kv for the first



three, and 8 and 10 kv for the other two. A linear capacity vs mechanical movement relationship is maintained, except at minimum capacity when fringe effects cause a small deviation. The capacitors, the largest of which measures only 9.5 by 3.5 inches, are designed to comply with the requirements of RCS11.

Canadian Marconi Co., Toronto.

High-voltage vhf transistor 127

High-voltage npn silicon epitaxial mesa transistor type 2N707A has a collector-base voltage rating of 70 volts and a power dissipation of 1 watt. It is intended for vhf oscillator and class-C amplifier applications. Capable of oscillating at frequencies in excess of 600 Mc, the 2N707A also features a low typical collector saturation voltage of 0.18 volts, and collector capacitance of 4 pf.

Canadian Motorola Electronics Co., Toronto.

Zener diodes 128

A sweeping range of 250 mw rated JEDEC glass zener diodes now available from International Rectifier Corp. span the voltage range from 2.6 volts to 13 volts, provide voltage tolerance of ± 1%, ±5% and ±10%. Units feature low dynamic impedance values (from 4 to 60 ohms) and low temperature coefficients. Types 1N465-1N479 cover the voltage range from 2.6 to 7.1 volts, and are available in ±1% and ±5% voltage tolerances. Types 1N702-1N716 range from 2.6 to 12 volts with ±5% and ±10% tolerances. Types 1N761-1N766,

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One of our clients, Canadian Motorola Electronics Co., has requested our assistance in locating and selecting a Product Engineer.

Applicants should be currently employed in a supervisory capacity, and should preferably have experience in F.M. Radio Communications and Auxiliary Equipment. Applicants should be conversant with the latest technological advances in the Communications Art and must be eligible for membership in the Association of Professional Engineers.

The desired age level is approximately 30 to 40. The salary is open and will be fully commensurate with experience and ability. There is a realistic opportunity for rapid advancement in a professional environment.

Applicants should mail complete details of background including age, education, technical qualifications, business history and present salary, in confidence, to:

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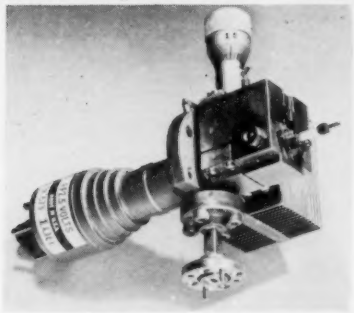
range from 4.8 to 13 volts in ±10% tolerance types.

Douglas Randall (Canada) Ltd., Scarborough, Ont.

Reflex klystron 129



Type QKK971 reflex klystron operates over a 100 to 120 Gc range with 10 mw power output and a minimum life of 250 hours. It is an integral-cavity type with smooth vernier tuning. Anode voltage is 1,700 volts, with an anode current of 50 ma. Heater requirements are 2.5 volts at 1.5 amps, and reflector voltage is -100 to -300 volts.

Raytheon Canada Ltd., Waterloo, Ont.

Circuit designs 130

Micro Switch Div. has expanded its 400EN series to include four circuit designs. They are four single-pole double-throw basic switches housed in slim 1 in. diameter housings which are completely sealed. Two actuator styles are available. The 404EN1-6 has a plunger actuator for operation by an in-line motion. The 444EN1-6 has a positive drive rotary linkage-lever for actuation and release under adverse conditions of ice and dirt. Electrical rating is 24 amps maximum inrush and 7 amps resistive at 28 vdc.

Honeywell Controls Ltd., Toronto.

Miniature wire-wound resistors 131

The new Axiohm line of miniaturized wire-wound power resistors is available in seven sizes from 2 watts to 12.5 watts. Resistance values range from 0.1 to 75,000 ohms. Standard resistance tolerance is ±5%, but closer tolerances are available on special order. The resistors are suitable for use with printed circuits, instrumentation and other miniaturized applications.

Ward Leonard of Canada Ltd., Toronto.

Multi-pole plug and socket 132

Unitor is a multi-pole plug and socket combination requiring low insertion and withdrawal forces and is suitable for use with rack-mounted electronic equipment where electrical connections are required at the rear of the sub-units. 35 pole, 70 pole and 91 pole types with silver plated contacts are in production. All are polarized.

Ferranti-Packard Electric Ltd., Toronto.

(Continued on page 64)

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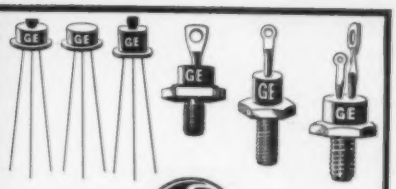

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IRE News

Section meetings

Hamilton: October 18; Joint meeting with the Buffalo-Niagara Section of IRE at the Sheraton Brock Hotel, Niagara Falls, Ont. Reception begins at 6.30 p.m., with dinner at 7.30 p.m. A speaker from Texas Instruments Inc. will give a 'State of the art' report on semiconductors.

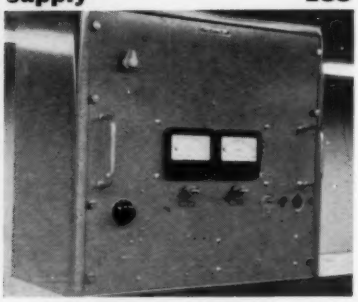
Toronto: October 23; This meeting of the Toronto Section is being organized by the PGCS Chapter. The speaker and title have not been confirmed, but the meeting will be on the subject of communications.

Chairmen of IRE Sections in Canada are invited to submit news of local meetings for publication in this column of CEE. Deadline for copy is the 15th of each month for inclusion in the issue which will be mailed the 4th of the following month.

All members of IRE having news of interest are invited to send it in to the Editor.

New equipment—cont.

Stabilized power supply 133

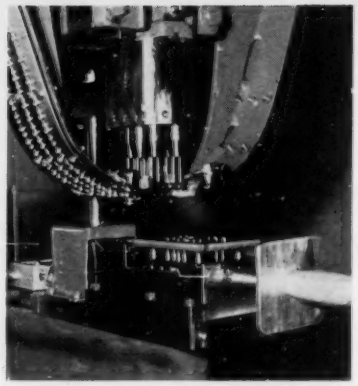


Model RS41 is a low voltage, high current stabilized power supply with two ranges: (a) 6.4 volts ±1 volt at 60 amps. (b) 12.8 volts ±2 volts at 30 amps. Stability is 0.1% against line or load variations; ripple is less than 25 mv at full load.

Gomard Electronics Ltd., Hamilton.

Eyeletting machine 134

Model F eyeletting machine is capable of setting from 1 to 12 eyelets at a time, depending upon the configuration of the eyelet pattern. This machine has a setting pressure of 2½ tons, which ensures uniform setting of all eyelets every time. When desired, this machine can be integrated with conveyors, turntables, indexing heads, loading devices, or other production mechanisms performing related work. In the picture, the machine has been adjusted to feed and set six eyelets at one time in a plastic part used in electronic equipment.



United Shoe Machinery Co. of Canada Ltd., Montreal.

Speakerphone 135

No. 3-A speakerphone system permits a subscriber to conduct telephone conversations without having to use a handset, leaving the hands free or permitting groups to participate in a single telephone call. A microphone picks up the speaker's voice, and incoming speech is heard through a small loudspeaker near the telephone set.

Northern Electric Co. Ltd., Montreal.

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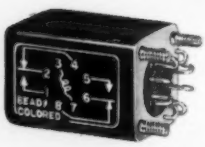

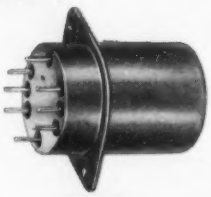

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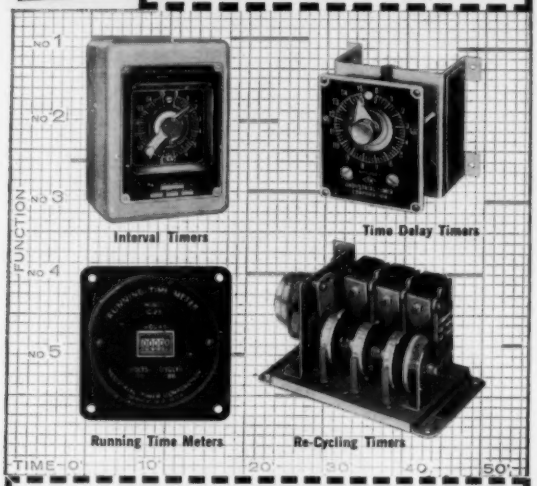

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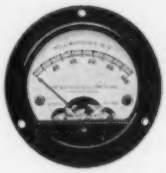

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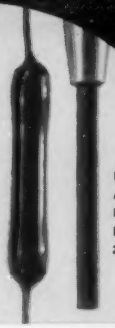

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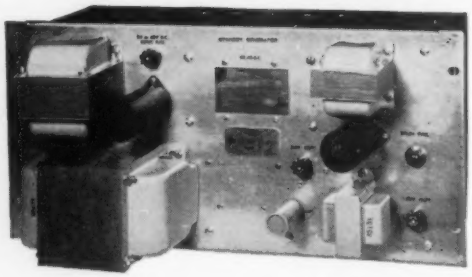

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RG-1	14/48V D.C.	20C/S A.C. @ 20W
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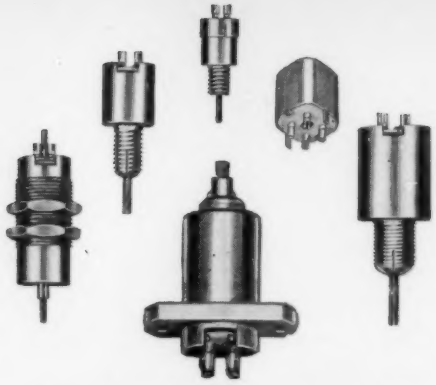

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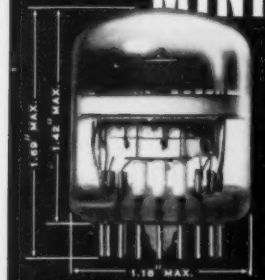

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Incorporating a routing-guide system to provide glow direction sensing, this new cold cathode tube reduces the process of multi-stage, reversible, bi-directional counting and selecting to its simplest terms. This means fewer components, resulting in increased reliability and reduced costs. Ruggedly constructed, the GS10H follows the long Dekatron® tradition for reliability and performance.

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In the slim, functionally-designed PERMA COOL IMPERIAL handle, Ungar introduces a completely new heat sink principle. A double cushion of air, combined with five heat transition surfaces, evenly dissipates heat, keeping the handle cool and comfortable at body temperature all day long.

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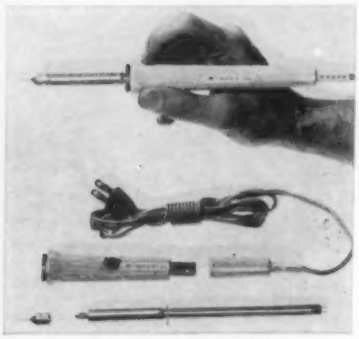

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Official of British IRE will visit Montreal and Toronto

Graham D. Clifford, General Secretary of the British Institution of Radio Engineers will visit Canada this month.

Sections of Brit. IRE are already operating in Montreal and Toronto, and Mr. Clifford will assist in the further development of the Institution in Canada. He will be visiting a number of industrial plants and Government establishments, and his discussions will include the possibility of forming a Canadian Institution which will, however, still enjoy the advantages of the Chartered Institution.

A Royal Charter was granted the British Institution of Radio Engineers August 2. Lord Mountbatten, who was president in 1947/48, has been named Charter President of the Institution.

Mr. Clifford may be contacted at the Mount Royal Hotel, Montreal, from October 4, and at the Royal York Hotel, Toronto, October 9. He will return to Montreal October 19 to present the Brabazon Award to four scientists from National Research Council.

The award was won by H. Ross Smyth, Dr. D. M. Makow, S. K. Keays and R. R. Real with their paper "A low-drain distress beacon for a crash position indicator."

Broadcast engineers to meet in Toronto

The Engineering Section of the Central Canada Broadcasters Association will hold its tenth annual conference at the King Edward Sheraton Hotel, Toronto, October 17-18.

These are the program highlights: Opening address by R. E. Misener, president of CCBA; Radio program automation, by G. Robitaille of CFPL, London; TV rebroadcasting, by G. Skinner, CKOS-TV, Yorkton, Sask.; Remote line problems, by M. Shields of CJLX, Fort William; Operation and design aspects of a TV lighting system, by H. Wright and C. W. Shearer, CBC; Computer type program automation, by P. R. Ely of IBM; Stereo broadcasting, by C. Eastwood, CFRB, Toronto; Transistor applications in radio and TV, by a representative from Ryerson Institute of Technology; Optics, by a representative from Taylor-Hobson Co.; Description of the educational projects undertaken by CCBA in 1961, by W. D. McGregor, CKCO-TV, Kitchener.

Following a tour of CFTO-TV on the afternoon of Oct. 18, the delegates will assemble for their annual reception and banquet.

President of IHFM will address hi-fi show

Raymond V. Pope, president of the Institute of High Fidelity Manufacturers, Inc., New York, will address the 1961 Pre-Exposition opening of the Toronto High Fidelity Exposition. The event will be the Exhibitor-Dealer reception and dinner which is to be held October 17 in conjunction with the Exposition at the Seaway Hotel, Toronto.

The Exposition, sponsored by the Dominion High Fidelity Association will open exhibit rooms to dealers from 10 am to 2 pm daily, Oct. 18, 19 and 20. The displays will be open to the public from 2 pm until 11 pm those days, and from noon until 11 pm on Oct. 21 (Saturday).

Toronto Section of AIEE presents lecture series

In response to an earlier questionnaire, a lecture series on digital computers will be given this winter, under the sponsorship of the Toronto Section of the American Institute of Electrical Engineers.

Lectures will be given Tuesday evenings, commencing Oct. 31. Registration fee will be $10 to cover cost of refreshments, lecture notes, etc.

For further information, phone or write W. Sanders, Ontario Hydro, 620 University Ave., Toronto 2 (368-6767, local 22125), or G. W. L. Davis, Ferranti-Packard Electric Ltd., Industry St., Toronto 15 (762-3661, local 206).

COMING EVENTS

October

2-6 90th Convention of SMPTE, Lake Placid Club, Essex County, N.Y.

3-12 'New Generation' Computer Exhibition, National Hall, Olympia, London, England.

8-11 International Systems Meeting of the Systems and Procedures Assoc., Cleveland.

9-11 National Electronics Conference, International Amphitheatre, Chicago.

9-12 11th Annual Instrument Symposium and Research Equipment Exhibit, National Institutes of Health, Bethesda, Maryland.

10-13 Fall Convention and Technical Exhibit of the Audio Engineering Society, Hotel New Yorker, New York.

11-13 14th Annual Gaseous Electronics Conf., Schenectady, N.Y.

16-19 2nd International Congress on Vacuum Technology, Sheraton Park Hotel, Washington.

17-18 Annual meeting of the Engineering Section of Central Canada Broadcasters Association, King Edward Sheraton Hotel, Toronto.

17-21 Toronto High Fidelity Exposition, Seaway Hotel, Toronto.

19-20 Annual Convention of the Canadian Independent Telephone Association, Royal York Hotel, Toronto.

23-27 International Symposium on Aero-Space Nuclear Propulsion, Hotel Riviera, Las Vegas, Nevada.

24-25 American Society for Quality Control, Product Maintainability Working Seminar, Sheraton Hotel, Philadelphia.

26-27 American Society of Tool and Manufacturing Engineers 29th semiannual meeting, Royal York Hotel, Toronto.

30-31 Radio Fall Meeting, Hotel Syracuse, N.Y.

CEE receives comprehensive information about the majority of technical meetings in North America, England and France. Readers wishing to check specific dates or other information about meetings are invited to write or phone the editor.

Transistor amplifiers

Continuing his work previously reported in CEE, H. L. Armstrong of Queen's University has prepared an article, "A simplified treatment of the behaviour of transistor amplifiers at different frequencies." This work will be published in the Nov. issue of CEE.

A comprehensive paper on the operation of linear diode detectors has been prepared by J. K. Pulfer of National Research Council. It will be included in the Nov. issue.

Another feature will be a report on the IRE Canadian Electronics Conference.

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STANDING WAVE INDICATOR

- **Pinpoint resolution for precise attenuation measurements**
- **Scale expansion with no "blind spots," no resetting**
- **Built-in bolometer protection**
- **AC or battery operation**
- **All-solid-state design**

415C Standing Wave Indicator

Model 415C Standing Wave Indicator is a new high-gain, low-noise solid state amplifier and voltmeter calibrated for square-law detectors to read directly in SWR or db. The amplifier is tunable, 980 to 1,020 cps, for matching source modulator or for optimizing several instruments in one system. Variable bandwidth (15 to 100 cps) permits both high sensitivity testing and swept-frequency work.

For highest resolution on precise attenuation measurements, you can expand to full scale each 2.5 db portion of any 10 db range with no "blind spots," and the reference is maintained automatically! This expansion gives you 24 calibrated ranges, 0-60 db, in 2.5 db steps. The 415C also reads directly in SWR; it is ideal for measuring reflection coefficient and extremely useful as a null indicator for audio-frequency bridges.

Two peak-limited bias currents, readable on the front-panel meter and adjustable ± 10%, prevent accidental bolometer burnout. Other inputs permit operation with crystals and as a null detector.

The 415C has both an ac output for use as a high-gain tuned amplifier and a dc recorder output. High stability with line changes makes the instrument ideal for long-term monitoring. An internal battery pack (optional) makes the 415C completely portable. It is housed in the new modular cabinet, which can mount in half of a rack 7" high, combining conveniently in a single rack width with such companion instruments as 431 Power Meter.

SPECIFICATIONS

Frequency:	1,000 cps ±2% by front-panel control. Special-order frequencies available between 400 and 1,500 cps.
Sensitivity:	0.1 μv rms at 200 ohms and 30 cps bandwidth.
Noise Level:	5 db below full scale at 0.1 μv rms sensitivity, minimum bandwidth.
Bandwidth:	Variable, front-panel control, 15 to 100 cps.
Range:	70 db. Input attenuator for 60 db in 2.5 db steps, accuracy ±0.1 db/10 db step. Maximum cumulative error, ±0.2 db.
Expand Accuracy:	±0.05 db from normal to 0.1 db expand; ±0.1 db from normal to other expand ranges
Meter Scales:	SWR 1-4; SWR 3-10; expanded SWR 1⅓ db 0-10; expanded db 0-2.5. Bolo current.
Input:	"Bolo"—200 ohms, bias 8.7 or 4.3 ma; "Crystal"—200 ohms for crystal rectifier; "200 Kilohm"—for crystal rectifier as null detector.
Outputs:	DC (1 ma full scale) for recording. AC (0.25 v rms for full scale deflection) for swept-frequency scope presentation.
Size:	7½" high, 6½" wide, 12½" deep. Weight, 5 lbs.
Accessories Available:	Battery pack.
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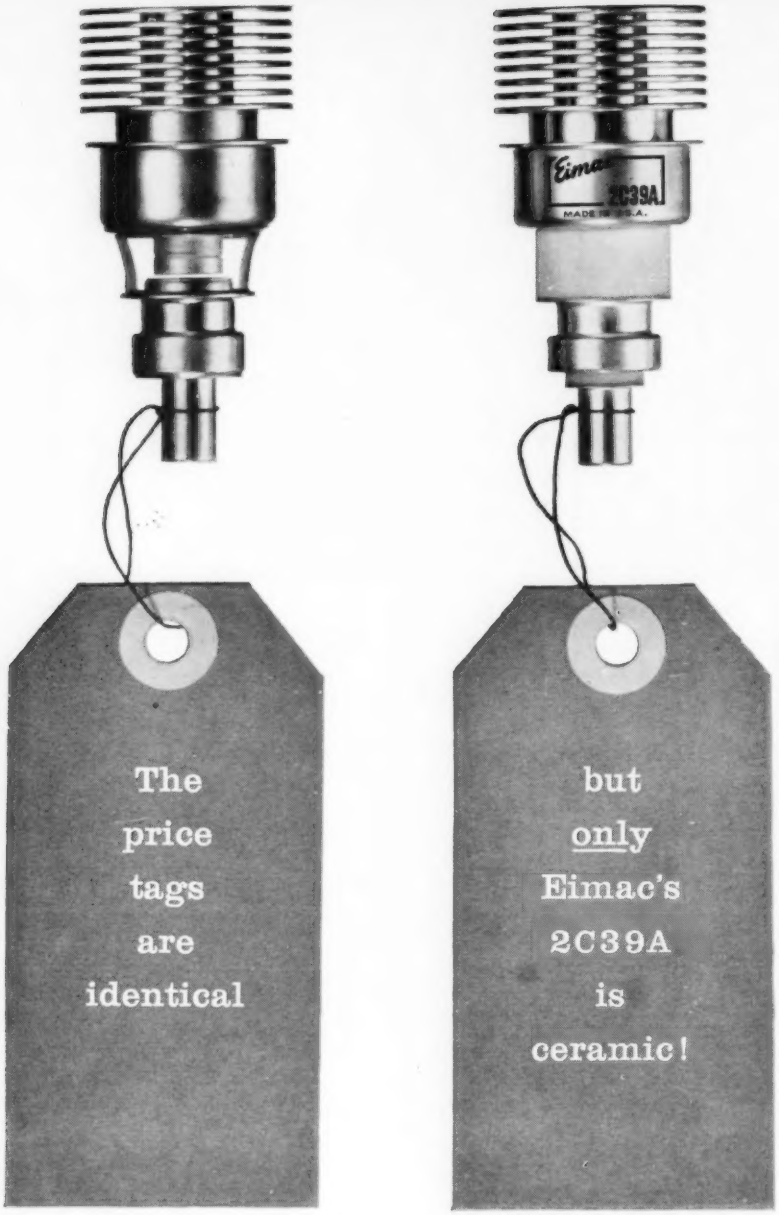

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